SCIENTIFIC AMERICAN

No. SUPPLEMENT 325

Scientific American Supplement. Vol. XIII. No. 325. Scientific American. established 1845. NEW YORK, MARCH 25, 1882. Scientific American Supplement. $5 a year. Scientific American and Supplement. $7 a year.

ENGINES OF LA FRANCE.

THIS steamer plies on the French line between New York and Havre. The following, with our engraving, we find in the *Engineer:*

MOVEMENT OF ENGINES.

Revolutions per minute	58
Mean speed per hour	10·25 knots.

SCREW.

Griffith's four blade—	
Diameter	16 ft. 8·79 in.
Pitch	22 ft. 7·63 in.

CYLINDERS.

Number	3
Diameter	4 ft. 11·85 in.
Stroke	4 ft. 1·24 in.
Diameter of steam pipe	1 ft. 4·54 in.
Diameter of exhaust pipe	1 ft. 5·53 in.
Area of ports of main valve	235 square in.
Range of expansion	11·8 in. to 23·6 in.

PISTON RODS.

Diameter of piston rods	6·88 in.

SCREW SHAFT.

Diameter, mean, of screw shaft	1 ft. 0·99 in.
Length of shaft	147 ft.

CONDENSERS.

Number	2
Number of tubes in each	1,045
Diameter of interior of tubes—tinned copper	0·87 in.
Diameter of exterior	0·94 in.
Length	4 ft.
Surface, total for condensation	5,113 square ft.
Diameter of injection pipe	7·08 in.
Surface for condensation per horse power	3·44 square ft.
Number of stay tubes	16

AIR PUMPS.

Number	2
Diameter of pistons	2 ft. 9·08 in.
Stroke	2 ft. 8·29 in.

FEED PUMPS.

Number	2
Diameter of plunger	7·87 in.
Stroke of plunger	2 ft. 8·29 in.
Capacity per stroke	5·5 gallons.
Capacity per hour per horse power	·26 gallons.

BILGE PUMPS.

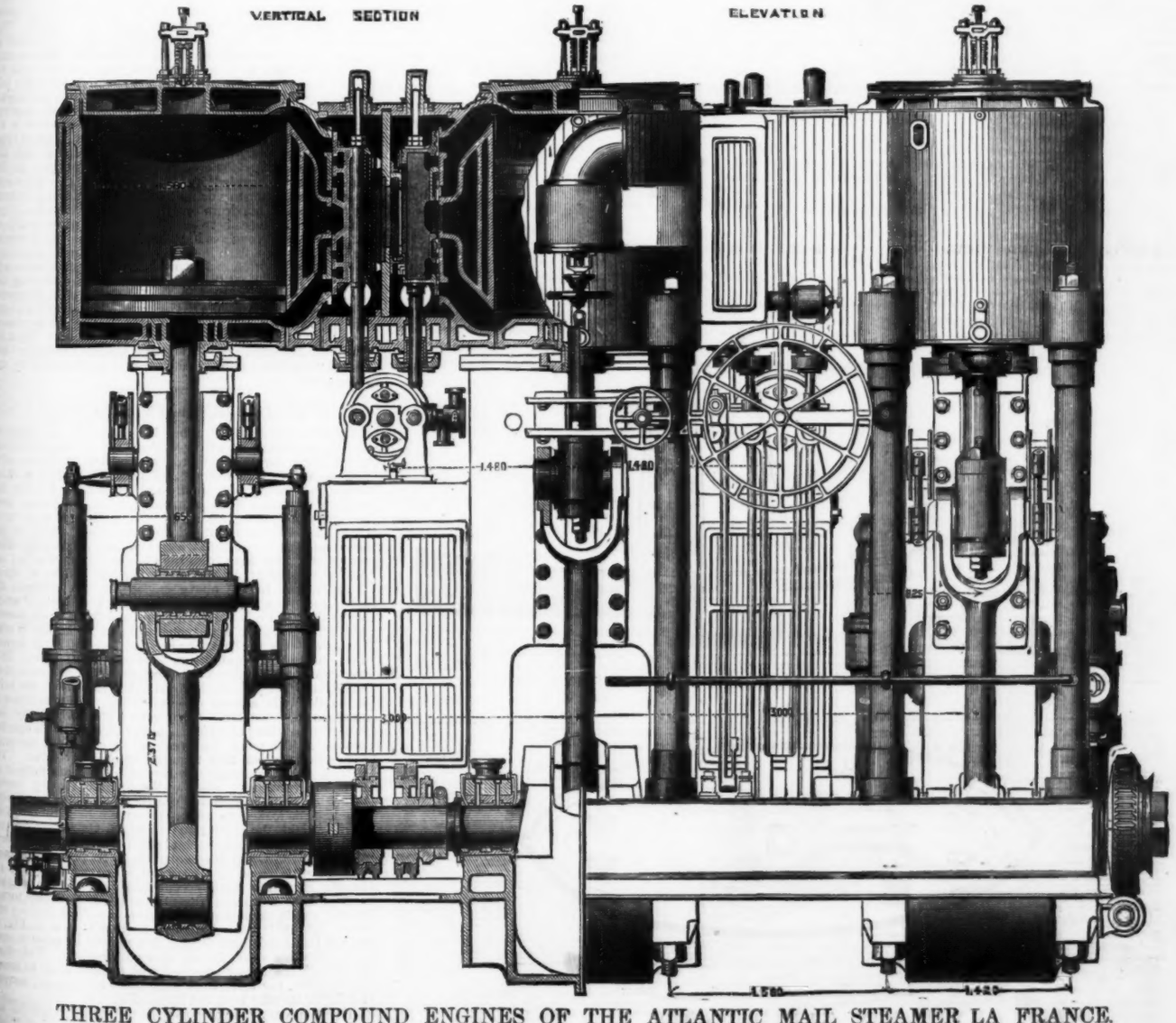
Number	2
Diameter of plungers	6·29 in.
Stroke	2 ft. 8·29 in.
Volume of one pump	3·5 gallons.
Capacity per hour	23,385 gallons.

BOILERS.

Number	4
Number of furnaces in each	4
Pressure	40 lb.
Number of tubes	832
Number of stay tubes	16
Diameter, interior, of stay tubes	3·35 in.
Diameter, exterior, of stay tubes	3·74 in.
Length of stay	8 ft. 1·64 in.
Length of ordinary tubes	7 ft. 10·65 in
Length of grates	7 ft. 6·5 in.
Width of fire	3 ft. 1·4 in.
Number of bars	69
Length of bars	2 ft. 6·16 in.
Grate surface	22 square ft.
Heating surface, furnace	118·4 square ft.
Heating surface, tubular, per furnace	446·72 square ft.
Heating surface, total, per furnace	565·12 square ft.
Per boiler	2,260·5 square ft.
Diameter of the chimneys, two	5 ft. 10 in.
Ratio of section of chimney to grate surface	0·1332

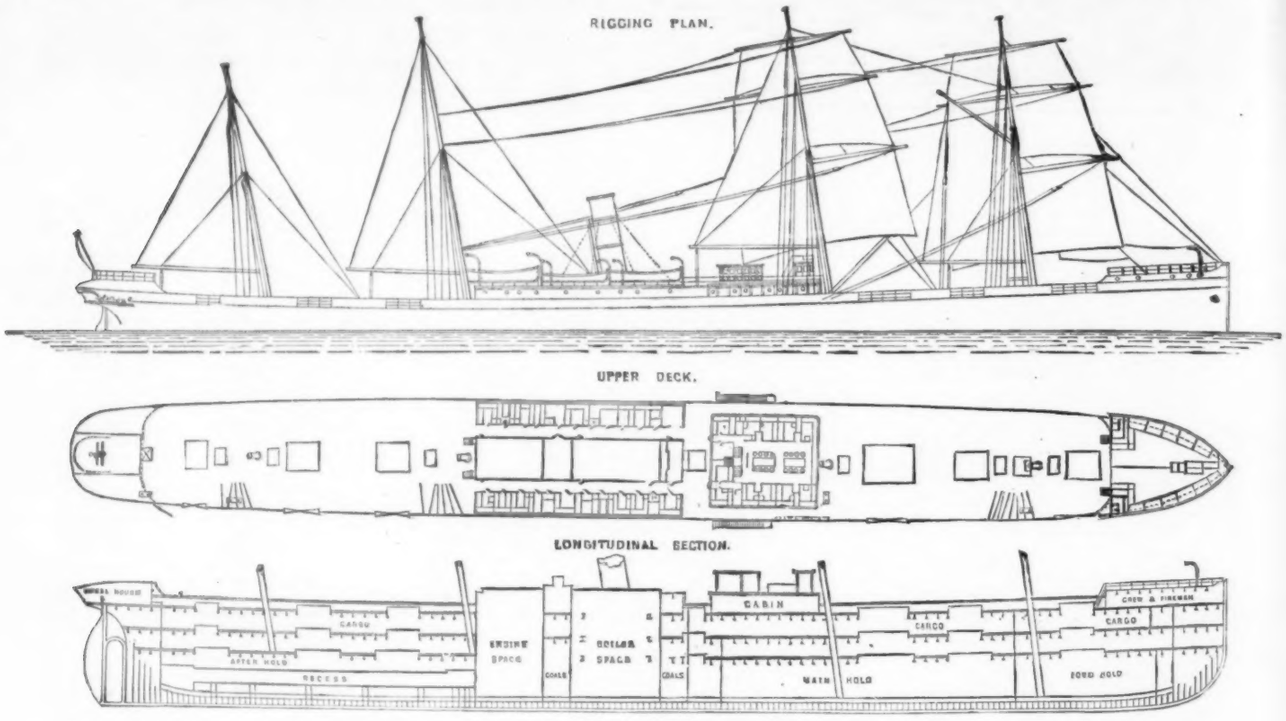
THE NEW STEEL STEAMER MERTON HALL.

THE screw steamer Merton Hall, which was launched on December 22, is a steel steamer of 4,178 tons gross register, and is the largest vessel yet built in Dundee or the east of Scotland. Her extreme length is 411 feet, or 400 feet between perpendiculars; extreme breadth, 42 feet 3 inches; depth of hold, 29 feet 6 inches. The Merton Hall has been built and engined by Messrs. Gourlay Brothers & Co., to the order of Messrs. Alexander & Radcliffe, of Liverpool, for their Hall line of steamers, which run between Liverpool and Bombay. The Hall liners do not carry a large number of passengers, but very comfortable quarters are provided for twenty-four first-class passengers in a house on deck; and as the Merton Hall will have a good rate of speed, her cabins will, no doubt, be well filled—as indeed those of this line generally are. The rigging plan shows that the Merton Hall will have four masts—two square rigged, and two with fore and aft canvass. The fore part of the vessel will be protected by a forecastle of turtleback shape. The engine and boiler spaces, which are of vital importance, are entirely covered, and there is a hood aft to protect the wheel and prevent water being shipped over the stern. The bulwarks are partly close and partly open; they are close where the sea is most likely to break on board, and open where it can best get clear, so that

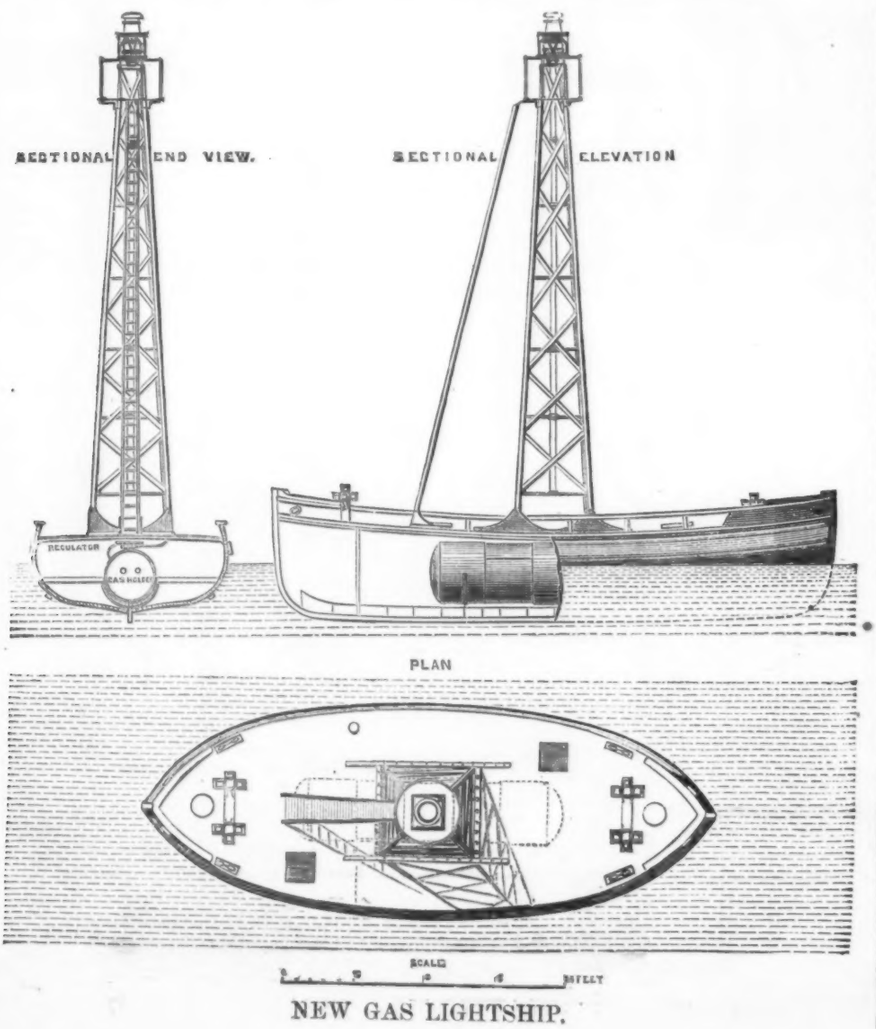


THREE CYLINDER COMPOUND ENGINES OF THE ATLANTIC MAIL STEAMER LA FRANCE.

no great quantity of water can ever remain on deck. From the longitudinal section it will be seen that the vessel has three decks; these are of steel, and will give great longitudinal and transverse strength. The cabin is placed nearly amidships, and forward of the engines and boilers, so that the passengers will be free from the disagreeable accompaniments of moving machinery. The officers' berths are placed amidships alongside the engines and boilers, and are of the most comfortable character. The engines which are to be fitted on board the Merton Hall are to be high and low pressure and surface-condensing, of four hundred and sixty nominal, or two thousand five hundred effective horse-power. The cylinders are respectively forty-five and eighty-four inches diameter; and the length of stroke five feet. The pressure of steam is to be 80 lb. per square inch, and will be supplied by three double-ended boilers having fourteen corrugated steel furnaces. The Merton Hall will have the highest class at Lloyd's, and everything will be done to fit her for the service intended. Besides the large engines for driving the vessel, there will be eight pairs of double engines and two single ones. These will be employed in steering the vessel, lifting the anchors and cargo, and pumping water. The steering engine will be placed far aft, so that passengers may not be disturbed by it.—*Marine Engineer*.



THE NEW STEEL STEAMER MERTON HALL.



NEW GAS LIGHTSHIP.

NEW GAS LIGHTSHIP.

THE illustration below shows a new gas lightship made for the Clyde Lighthouse Trustees by the Pintsch Patent Lighting Company, New Broad street, London. The company has already supplied the trustees with a number of gas-lighted buoys similar to those made for the Trinity Corporation, and for lighting the entrance to the Suez Canal. The lightship for the Clyde Lighthouse Trustees is 40 feet in length, 14 feet in beam, and 7 feet in moulded depth to rail. The gas cylinder is of wrought iron, very carefully put together, and of a sufficient capacity to keep three small jets burning in the lantern for 40 days, burning day and night, gas being passed into this holder at a pressure of about seven atmospheres. The regulator, by which the pressure is reduced in the burner to about 2 inches of water, is placed just above the cylinder, and not immediately underneath the lens, as is generally the case in gas-lighted buoys. In the space usually occupied by the regulator is clockwork, which gives motion to a drum within the lamp and surrounding the light. This drum or cylinder is slotted with a given distance or distances between the slots or a given width of slot, so that as it revolves it alternately covers and discloses the light, giving a flash light with determinate intermission. In this ship the drum makes one revolution per minute, and gives four white light flashes. The weight for driving the clockwork descends through the tube shown in the center of the framework carrying the lantern. The clockwork only requires winding once in forty days. It may be here mentioned, says the *Engineer*, that the application of Pintsch's system of lighting in the Dublin and Holyhead steamers has proved very successful, and is much appreciated by the passengers.

EQUILIBRIUM SAFETY VALVES.

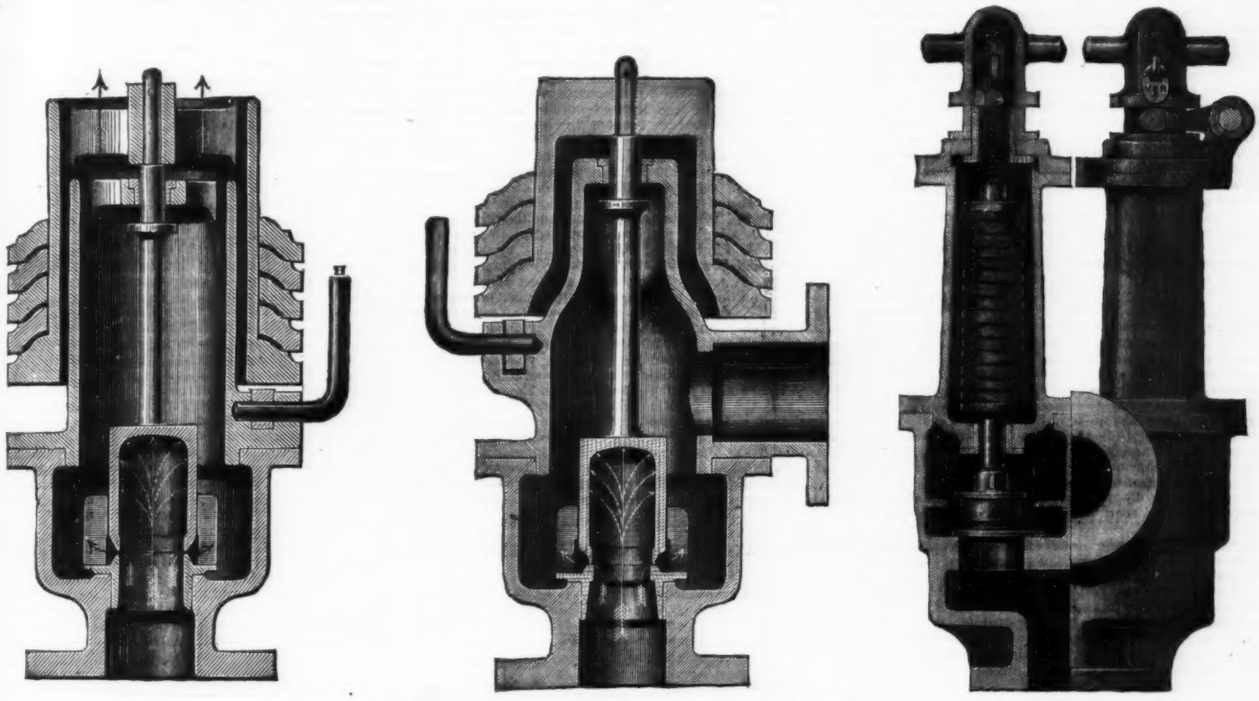
CONSIDERABLE attention has been given of late years to the improvement of safety valves; nor is this attention unnecessary, for upon the proper construction of the valve depends its correct working, and upon its correct working depends the safety of both life and property. It is not too much to say that a great number of boiler explosions have been caused by defective safety valves, perhaps many more than have ever been traced to this cause, owing to the destruction of the fittings, which generally accompany boiler explosions. We have from time to time brought before our readers various appliances for relieving boilers of steam pressure, and in the above engravings we illustrate the latest invention of this kind that has been brought under our notice. This is the equilibrium safety valve of Messrs. Alexander Turnbull & Co., engineers, of St. Mungo Works, Glasgow. On the next page, Fig. 1 is what is termed Turnbull's patent equilibrium dead-load safety valve. It is used chiefly for stationary boilers, and they are such that, when the boiler pressure is equal to the valve load, the valve is practically in a state of equilibrium, so that increase of pressure is prevented. They give a gradual, steady, and full opening; they also close again practically at the opening pressure. The valve load required is only from one-tenth to one-twentieth of that required by ordinary valves. The valve is guided externally by six feathers which project up from the valve seat, also by the spindle passing loosely through a brass bush in the central boss of the escape pipe. The valve is loaded to 20 lb. per square inch by the cylindrical weight, the central boss of which rests upon the top end of the spindle, and each of the ring weights, as shown, applies an additional load equal to 10 lb. per square inch. The valve is eased or blown off, when necessary, by the handle, H, and a small eccentric, lifting up the weights, and in such a manner that the valve is partially turned round, and in re-closing comes down on a fresh bearing surface. Fig. 2 is a similar valve to that shown in Fig. 1, except that a side branch pipe is provided in order to conduct the waste steam in any desired direction. This form of valve is frequently provided with a cover, so as to incase the weights, the valve thus being made to lock up, tampering being thereby rendered impossible.

Fig. 3 shows a pair of spring-load lock-up valves (in one chest) for marine purposes, as made to pass Board of Trade

and Lloyd's registry. In these valves, as in the others, there is an absence of internal guide ribs, etc. They are guided exclusively by the spindle and by only two bearings, so that the friction in working is reduced to a minimum. The loading of the valve is effected by the compressing of the spring by the screw at the top of the valve. After the valves are set to the working pressure, a distance ring is inserted under the head of the compressing screw, so as to prevent any further compressing of the spring.

The defects of ordinary safety valves were long since demonstrated by a series of practical experiments made by M. Burg, of Vienna. It is also known that to enable an ordinary valve to rise to an appreciable distance from its seat, the pressure in the boiler must greatly exceed that pressure for which the valve is loaded. In the report upon safety valves by the Institution of Engineers and Shipbuilders of Scotland, the experiments made upon a tubular boiler, fitted with two new lever safety valves, and having their area equal to the Board of Trade rule, show that for a boiler pressure of 5 lb. the increase of pressure above the load was 160 per cent., and for a pressure of 45 lb. the increase was 15·5 per cent., and therefore they recommend a much larger valve area for low pressures. In an article upon safety valves by Mr. McFarlane Gray (chief examiner to the Board of Trade), an experiment is recorded as follows: "I have just experimented upon two factory boilers, connected. Total fire-grate area, 26 square feet, fitted with four safety valves, loaded by lever and weight in the usual way, to 51 lb. pressure. Each valve was 3 inches in diameter, and therefore the valve area was more than double the Board of Trade rule, being 28 square inches for 26 square feet of fire-grate. All the valves were in fair working order. Arranged to have good fires before the dinner hour. At 1 P.M. the pressure was 48 lb., engine stopped. At 1:1 P.M., pressure 50 lb., safety valves all breathing. At 1:2 P.M., 51¼ lb., valves all blowing. At 1:4 P.M., 55 lb., valves blowing strong. At 1:5 P.M., 58 lb., steam escaping, prevents marking lift. At 1:7 P.M., 60 lb., can hardly see the gauge for steam. The pressure was evidently still rising fast. We then opened the furnace doors, shut the dampers, eased one of the valves, and started the engine to reduce the pressure. The impression made upon all present was that these boilers had not too much valve area."

We might go on multiplying these experiments, but our purpose will be better served by giving only one more, which is of value as affording a comparison between the ordinary and the Turnbull valves as regards their respective discharging powers. This experiment was made at the Crown Ironworks, Glasgow, upon a new double-flued boiler with 18 Galloway tubes, and having 31 square feet of fire-grate. The boiler was fitted with two weighted lever safety valves, each 5 inches in diameter. The valve area, therefore, was more than 2½ times the Board of Trade rule, being 39·6 square inches for 31 square feet of fire-grate. The valves began to lift at 46 lb., and to blow at 47 lb. The pressure increased in the boiler to 55 lb. before all the steam generated in the boiler could escape, being an excess of 9 lb. Upon this same boiler was fitted one of the Turnbull safety valves, 1¼ inches in diameter. This valve began to lift at 48 lb., and it was found that though the fires were urged to their utmost, the pressure in the boiler could not be got to exceed 50¼ lb. The pressure oscillated between 50¼ and 49¼, showing that this small valve was more than a match for the boiler, and that, although it was only 1·23d part of the area of the two 5-inch valves, it was four times more efficient in preventing increase of pressure. This valve was one of the first made. They can now be seen giving an opening of one-fourth of the diameter with an increase of 1 lb., and will close promptly at almost the identical pressure at which they open. From what we have stated, it will be seen that the Turnbull valve meets both theoretically and practically the requirements of a perfect safety valve, and as such we commend it to the notice of our readers. Its value is established in practice, where it has proved very successful, as shown by numerous testimonials from firms of high repute which are now before us.—*Iron.*



IMPROVED EQUILIBRIUM SAFETY VALVES.

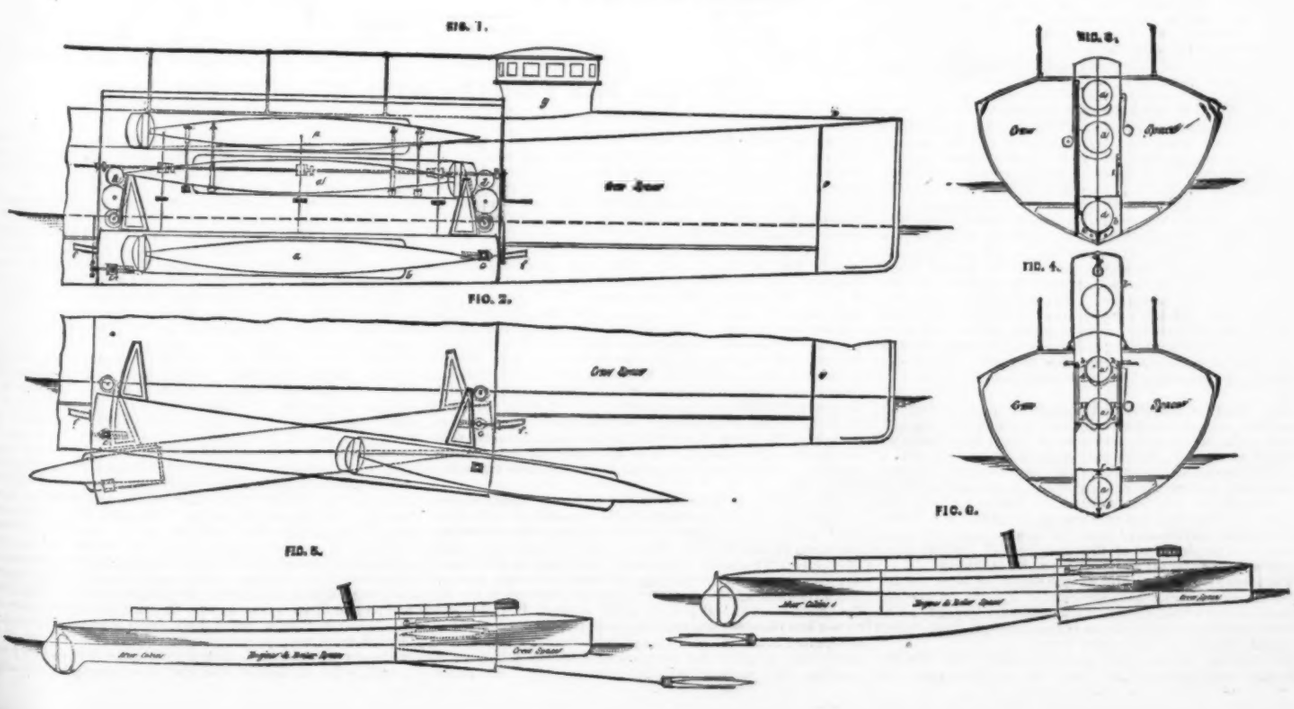
STOWING AND DISCHARGING TORPEDOES.

THE idea of an offensive attack by means of a boat specially constructed to carry an explosive machine, which would severely damage and probably wreck the vessel attacked, has existed more than a century.

This was in the first instance an American invention, brought out by Captain David Bushnell, of Connecticut, in 1775. His boat held only one person, and contained an air-tight chamber, with a sufficient quantity of air to support

AN IMPROVED METHOD OF STOWING & DISCHARGING TORPEDOES FROM TORPEDO BOATS OR OTHER VESSELS

BY MR J.B.ATKINSON M.I.N.A.



him for thirty minutes. Beneath this chamber was a water tight chamber fitted with means of letting in water or pumping out again, by the appliance of a force pump, for the purpose of sinking or raising the vessel at will. When at a proper depth below the surface, the boat was propelled under the bottom of the vessel to be attacked by an oar led to the air chamber, and by means of forcing, with an arrangement also from the air chamber, a screw into the bottom of the vessel, a torpedo regulated by clockwork would be left attached. In 1801, various experiments were made at Brest for the French Government, by the celebrated Fulton, the boat he used being a diving one, propelled by a scull worked by hand gearing. He made many useful experiments, and at one time blew up a small vessel. His plans and ideas were laid before our Government in 1804, but were cast aside as impracticable. Fulton, in the course of his experiments, developed the idea of the torpedo launch of the present day. He made a model of a 300 ton wooden vessel to have sides six feet thick, for the purpose of rendering them cannon proof, and decks six feet thick which were to be musket proof. She was to be propelled by hand by a scull-wheel, and to travel at a speed then considered a high one.

The torpedoes were fixed on the ends of spars fifty-six feet long, stayed by guys from the mast-head. From Fulton's time to the Crimean war, the torpedo question stood comparatively still; then, however, it only revived partially in the shape of stationary torpedoes or submarine mines, which were employed by the Russians for the defense of Sebastopol and Cronstadt.

Again during the civil war in America, torpedo boats were resorted to, and some vessels were blown up by their means. At the same time, for want of proper arrangement and management, they were in some instances blown up as well as the vessel they attacked. At the close of the war, both sides were busy in preparing special spar torpedo boats. Since then, vast strides have been made toward perfecting the efficiency of the torpedo boat in the most destructive method of attack. To carry this out, the speed of torpedo boats has increased from time to time to nearly double that to be obtained from them a few years ago. Owing to the immensely increased destructive power of naval guns since the time of Fulton, the idea of building small vessels shot proof has been abandoned; the torpedo boat of the present day, trusting to her speed and the small mark she shows as a target, to escape scathless. Fulton's idea of the method of attack by means of spar torpedoes still meets with a certain amount of favor and attention. At the same time, various other methods of stowing and discharging torpedoes have been proposed or tried with varying success.

In perfecting the stowage and discharge of torpedoes many things have to be considered. Torpedoes are bulky and heavy machines to move about in the confined limits of a steam launch, weighing as they do from three-quarters of a ton to a ton each. On this account they should be stowed as near the point of discharge as possible. At the same time, the point of discharge with the arrangements for discharging should be hidden from the view of the enemy, together with the knowledge of the direction in which the torpedo is aimed.

Again, as the torpedoes at present in use are supposed to strike an armor-clad below her armor-belt, the aim in discharging is to drive it on an object six or seven feet below the surface of the water. To accomplish this various methods have been tried to supersede the spar system.

In some instances, torpedoes are discharged from guns or tubes carried on the deck of the boat. Although accurate aim may be taken, the torpedo in entering the water generally meets with obstacles which prevents it from reaching its intended mark. The side crest of a wave will sometimes catch the point of the torpedo as it is breaking the surface, and throw it entirely out of the course it is intended to take. The small angle of entrance of the torpedo obtainable from the deck of a launch when discharged from these tubes frequently causes the missile to skim on the surface, by which course it wastes its force on the thickest portion of the armor belt of a man-of-war.

Another method in use is that for discharging torpedoes from channels cut at an angle to the deck, and running down by the side of the stem. By this method the torpedo is discharged under the surface of the water, but this is done at an angle which would necessitate the launch being very near the vessel to be attacked; at the same time, the operations for discharging must be carried on in the full view of the enemy. Other complicated arrangements have been made for discharging topedoes through holes or tubes through the bow of larger vessels, as well as ordinary torpedo launches, but a lot of time and manipulation is necessary to effect a discharge.

The figures on our illustrated sheet show a design by Mr. J. E. Atkinson, member of the Institution of Naval Architects, specially prepared to meet all the points set forth in a most simple and highly practicable manner.

The chief feature of the design will be seen to consist of a trunk or well space through the middle of the torpedo boat situated at the fore side of the boiler space, and far enough from the bow to escape being injured by a collision. At the bottom of the well a discharging trunk is fitted, capable of being momentarily placed in an oblique position, enabling the torpedo to be discharged in a direct line with the keel either forward or aft. The torpedoes, to the number of three, four, five, or six, according to the depth of the boat, may be stowed one above the other, on hinged brackets, in the trunk or well, and lowered in position for discharging in rapid succession. All observations are taken from the small conning tower at the fore end of the trunk or well from the crew space on the deck below, and every arrangement for discharging either ahead or astern can be made without the slightest sign that any such operation is in course of preparation, as not a single hand is required on deck.

Fig. 1 shows a longitudinal section of the well with the torpedoes, *a*, *a*, *a*, stowed, and the discharging trunk, *b*, closed. The points, *c*, *c*, are those on which the discharged trunk, *b*, is pivoted; these can be fixed or thrown out of gear at each end as required, at will, admitting of the trunk being lowered by means of the gearing, *d*, *d*, rapidly into the required oblique position either for a forward or after discharge. At the fore end of crew space, there is a watertight collision bulkhead, *e*; this crew space occupies not only the space at the fore end of the trunk or well, but the wings or side-spaces as far aft as the boiler-room bulkhead.

The tubes, *f*, *f*, at each end of the trunk or well, are impulse tubes, through which pressure is brought on the torpedo by steam or air, to give it the necessary impetus for an effective discharge, and *g* is the conning tower, from which all observations are taken under cover.

Fig. 2 shows longitudinal section of well, with the discharging trunk lowered for firing the torpedo ahead; the dotted lines show the discharging trunk lowered for firing the torpedo astern.

Fig. 3 shows a cross section through the well with the carrier, *h*, in position after lowering torpedo into discharging trunk. The dotted lines show the carrier raised for lowering the other torpedoes when required. The lid, *i*, is arranged to close tight while the torpedo is being discharged, and raised again, as in Fig. 4, when the trunk is replaced after discharging, so as to admit of placing another torpedo in position.

In Fig. 4 the hinged brackets, *k*, *k*, are shown; these support the torpedoes in position till they are required for use, when they are lifted by means of an attachment from the framework, *l*, the hinged brackets, *k*, *k*, are then swung aside, and the torpedo placed on the carrier, *h*, to be lowered in position for discharging.

Figs. 5 and 6 show the torpedo boat discharging ahead and astern respectively, and the chief divisions of after cabin, engine and boiler space, and crew space. The discharging trunk, *b*, fits the form of the bottom of the boat perfectly when in place, and thus keeps up the continuity of force and speed. The arrangements and provisions made in this design will be seen to meet more or less the requirements set forth to perfect the working of torpedoes. This arrangement of a trunk or well system could be applied to vessels of any class or size, and placed not only to discharge in a fore-and-aft direction but also athwartships, in case of the beam of the vessel admitting of such an arrangement. In a larger class of torpedo boat, wells could be placed fore and aft, one for firing torpedoes ahead, and the other astern. It will also be a highly practicable proceeding to fit a trunk or well of this kind loaded with torpedoes in coal barges, provision boats, or any other unlikely looking engine of destruction, by means of which the greatest damage could be inflicted on one or more vessels in the most unsuspected manner. Considering the simple and perfect arrangement of mechanism used in this system of discharging torpedoes, the direct line of fire they obtain by being discharged under the keel of the attacking vessel; the advantage thus gained by obviating the disturbing influences experienced in breaking their course through the surface of the water, and the compact manner in which they are stowed immediately in the position required for discharging, this design is worth the greatest attention of all governments interested in the destructive science of submarine warfare, and will doubtless in the immediate future become a subject of experiment and adoption by the various competing marine navies of our own and foreign countries.—*Marine Engineer.*

THE GUTZKOW PROCESS OF PARTING SILVER AND GOLD.

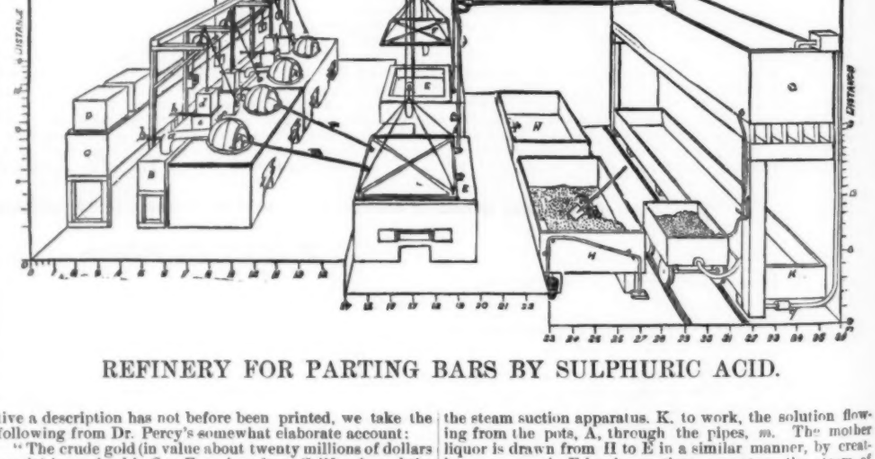
IN his recently published Volume I. of the "Metallurgy of Gold and Silver," Dr. John Percy describes at length the Gutzkow method of parting silver and gold. As that method has been in practical use for many years, and so authoritative a description has not before been printed, we take the following from Dr. Percy's somewhat elaborate account:

"The crude gold (in value about twenty millions of dollars yearly) is received in San Francisco from California and the adjacent States and territories in bars, cast and stamped by assayers in the interior, and is on the average 900 fine, with one to two per cent of base metal. The 'silver doré' comes mostly from the Comstock mines, which produce very fair bullion, 990 fine in gold and silver, with generally not less than two, but frequently as much as ten or more per cent. of gold. Some other districts, Reese River, for instance, send bars with only traces of gold, 800 fine in silver, the balance being copper. The works which treat the tailings from the Comstock mills turn out bullion with from one to two per cent of gold and fifteen or more of copper. Mexico sends its dollars, celebrated the world over for liberality in weight and assay, with just a trifle of gold, not worth mentioning per dollar, but agreeably surprising when parted by the ton. Japan sends occasionally its quaint square coins, containing 250 of gold per 1,000 and no copper, for refining; but there seems to be an end to the stock of coin in that country, as other people engaged in the Japanese trade have found out.

"The bullion is assorted in the following three classes: 1. Gold bars, which are melted and granulated with Comstock and low grade silver, to produce a proportion of nearly two parts of gold to three of silver, with a small percentage of copper. This alloy is probably the richest in gold that is anywhere subjected to parting, and was originally adopted when refinable silver was only sparingly obtained in the San Francisco market. When properly treated, it yields gold of not less than 900 fine (which is the standard required by the United States Mint), in large and hard grains, exceedingly well adapted for sweetening (that is, purifying by washing after parting), pressing, and melting. An experienced refiner will correctly predict the fineness which the gold will show after melting, within one thousandth, from its appearance when still in the refining-pot. 2. Comstock silver bars, which are parted *per se*, just as they come from the mine, chips being cut for assay. Formerly they were granulated with an addition of copper (or of low grade bars when on hand), and yielded gold of 960 to 980 fineness, which had to be melted with silver and copper and granulated, like crude gold, as described above. Besides, the gold was frequently 'mushy,' that is, soft and powdery, sweetening slowly, and settling with difficulty in water or acid. In 1867, Mr. John Reynolds, an intelligent workman, suggested the refining in bars. Of course, there was no doubt that even the heaviest bars would finally dissolve in hot sulphuric acid; but nobody then believed that a bar weighing nearly 100 pounds, twelve inches long, six inches broad, and five inches high, would dissolve in less time than when granulated. The result was, however, surprising. The charges of the refining-pots could be raised from 140 pounds to 2 0 pounds by operating upon bars instead of granulated metal; the dissolving was finished in four hours, as previously; the gold turned out, after the first and only boiling, of a wonderfully uniform fineness of 99 4; and last, but not least, the gold was hard and not 'mushy,' settling and sweetening rapidly. 3. Bars containing much copper, which are melted with higher grade until a proportion not exceeding twelve per cent. in copper is obtained. They are not granulated, but cast into bars, about one inch thick, and yield, by Reynolds's method, gold about 992 fine. The charge of the pot has to be somewhat smaller, in order to finish the parting in the same time as a charge of Comstock bars would require. It may be remarked here that the presence of a small percentage of lead rather facilitates than retards the dissolving of such coppery bars. Sulphate of lead is much more soluble in highly concentrated boiling acid when saturated with silver than is generally assumed. There is no trouble at all in refining silver bars with as much as five per cent of lead, excepting that the resulting gold is very brittle. The usual method in San Francisco of toughening fine gold bars is by sal-ammoniac and (in stubborn cases) by a weak blast on the surface of the molten metal, which is most effectual in removing lead from gold."

The flat-bottomed dissolving-pots, A, are less than two feet in diameter, and when new are only three quarters of an inch thick, wearing down to a quarter of an inch in the course of two years. Each pot has a separate fire-place, and is covered by a cast-iron dome, from which the lead pipe, *a*, leads to a closed tank, B, and thence through a larger pipe, *b*, to condensers. The sulphuric acid in the tank, C, is supplied to the pots by forcing a counterweighted plunger, *d*, into the bucket, *b*, through the overflow-pipe, *f*, thus discharging twenty pounds of acid into the pot.

Two hundred pounds of silver bars are dissolved with 300 pounds of sulphuric acid in four hours, the gold remaining behind as a hard and heavy gravel. The silver solution is siphoned off into the cast-iron pan, E, having a capacity of fifty cubic feet, by placing a cover, F, on it, and allowing



REFINERY FOR PARTING BARS BY SULPHURIC ACID.

the steam suction apparatus, K, to work, the solution flowing from the pots, A, through the pipes, *m*. The mother liquor is drawn from H to E in a similar manner, by creating a vacuum in E by the suction apparatus, the steam of which is utilized in heating the liquid with which the tank, G, is filled. Before running the silver solution into E, it is filled up to within three inches of the top with mother liquor from a previous crystallization, which consists chiefly of sulphuric acid of fifty-eight degrees Baumé, heated to about 250 degrees Fahrenheit. After the silver solution is added, sufficient water is put in to reduce the specific gravity of the solution to fifty eight degrees Baumé; otherwise, on cooling the silver would be separated partly or wholly as a bisulphate, which, on contact with water, would form a powder retaining much free acid, and would in that state be entirely unfit for further treatment. The object is to separate the silver as a mono-sulphate as hard as possible, from as acid a solution as possible, for which fifty-eight degrees Baumé is about the limit. Above that strength, the formation of bisulphate begins, never below. The addition of water to the contents of E serves also essentially to purify the solution. Any sulphate of lead still dissolved is, practically, wholly precipitated, and the cloud of sulphate of silver produced by the dilution with water clears the solution most rapidly of all suspended matter. The iron, which was present in the strong silver solution as an insoluble neutral sulphate of peroxide, and caused its yellow and muddy appearance, absorbs water in the weaker acid and settles as a greenish basic sulphate. Once every month, the sediment covering the pan, E, to about the height of two inches is removed and dissolved in water. It consists of sulphates of iron, lead, and silver, some gold, and a graphitic substance derived from the cast-iron pots and tools. The residue, after treatment with water, is mixed with some granulated zinc, to reduce the sulphate of lead, and, after having been washed

and dried, is melted in a small reverberatory furnace with the addition of carbonate of soda, no other flux being able to remove the graphite so rapidly.

The purified and clarified solution in E is siphoned off into the open pan, H, in which it is allowed to cool over night to about eighty degrees Fahr., and in it the sulphate of silver crystallizes so that the mother liquor can be pumped back into E. The crystals are removed to the filter-box, I, a layer of precipitated silver over the false wooden bottom serving as filter. A stream of a hot solution of green vitriol of twenty-five degrees Baumé is admitted from the tank, G, and allowed to percolate the crystals, converting them into a very heavy and dense mass of metallic silver, which retains the shape of the crystals. The sulphate of protoxide of iron is converted into sulphate of peroxide. The first portion of the solution contains some sulphate of copper, which is precipitated by iron. The solution of peroxide of iron is reconverted into protoxide solution by putting sheet-iron into it, thus rendering it fit to be used over again.

The more neutral the crystals of sulphate of silver and the solution of sulphate of iron is, the more rapid the reduction will be. The reduction of 700 pounds of silver, the result of dissolving the contents of four pots, is effected in three hours. The iron solutions which pass through the filter contain some silver, ninety per cent. being in the filter, seven and a half per cent. being obtained from the solutions in cooling and two and a half per cent. being regained by the corrosion of the iron solution by iron and by copper from the blue copper solution.

After sweetening with water, the silver is converted into cakes, three inches thick and ten inches diameter, by pressing it under a hydraulic press. They are dried and melted.

The gold remaining behind after dissolving is boiled again with fresh acid when obtained from granulated alloy. Gold from bars does not need this, being 996 fine at the first boiling.

ON WARMING AND VENTILATING OCCUPIED BUILDINGS.

By ARTHUR MORIN, Director of the Conservatory of Arts and Trades, Paris.*

1. The means for producing warmth and ventilation are so closely connected, especially during the cold season, that it is almost impossible to treat them separately, even in such a review of the teachings of science and experiment as the present, and hence both these subjects have been included in the title.

WARMING.

GENERAL CONSIDERATIONS.

2. *Heating apparatus.*—We may consider forms of heating apparatus in three different respects:

1. In regard to economy of fuel.
2. In regard to effect on health.
3. In regard to comfort.

For heating places occupied but for short periods, such as the vestibules of public buildings, stairways, waiting-rooms, and even churches, the first of these considerations should decide the choice of apparatus.

For occupied buildings, however, the second consideration should have more weight; and here we may give as a rule that every heating apparatus or system of heating which does not provide in itself for an ample and regular change of air, or which is not connected with suitable arrangements for producing such a change, is injurious to health.

In regard to the third consideration, while it is often opposed to the first, it is closely connected with the second, since there can be no method of producing pleasant warmth but such as is also healthful.

In the rapid review of heating apparatus which we shall make under these three heads we shall distinguish between those used for special purposes and those for general heating.

OPEN FIRE-PLACES.

3. At the head of comfortable and healthful forms of heating apparatus used within buildings are placed open fire-places, of which two different kinds may be distinguished:

1. Ordinary fire-places.
2. Ventilating fire-places.

The remarks which will be made in regard to the first, and the proportions suitable for them, will also apply to the second, which, indeed, only differ by having some special arrangements.

COMMON FIRE-PLACES.

Two distinct types may be considered. The first, which is the one most frequently met with, consists of a chimney

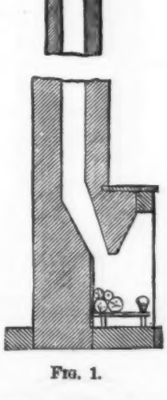


FIG. 1.

of proper size, connected with the hearth at the bottom by means of a more or less narrow opening, the lower part of which forms the passage which Rumford called the throat of the chimney (Fig. 1). On the upper part of the flue is placed a sort of ajutage, called a chimney-shaft when built of bricks or tiles, and chimney-cap when made of terra-cotta (Fig. 2). The opening for the escape of the smoke is much smaller than the sectional area of the main flue. This type is almost the same as that devised by Rumford, and which bears his name; but while he pointed out its advantages over the old forms of chimneys in regard to draught, he did not determine the correct proportions of the several parts.

In the second type, often met with in the upper stories of houses in Paris, the flue, which is usually cylindrical, has the same sectional area throughout. It has been recommended

FIG. 2.

by M. Peclet, in his treatise on heat, as proper for every case; but its use should be restricted to very small chimneys, and, in general, to cases where stoves are used for heating.

4. *General advantages and disadvantages of ordinary fire-places.*—Ordinary fire-places, which cause the removal of a considerable amount of air, and, therefore, the change of that in the apartments, present the incontestable advantage of forming a healthful mode of heating. But the air which is removed must necessarily be replaced by the external air, entering usually through the loose joints of the doors and windows, thus causing currents of cold air, which become more unpleasant the greater the size of the chimney or the stronger the draught produced by the fire. Consequently, as Rumford says, "the draughts chill one part of the body, while the rest is roasted by the fire in the fire-place, and this cannot but be injurious to health." All have noticed these effects near a large fire-place in which a strong fire is burning. It is especially in the large rooms of country-houses that these effects are most apparent and unpleasant.*

In other and frequent cases—especially in Paris, owing to the confined kitchens, the proximity of water-closets, and the application of weather-strips to the joints of doors and windows—the draught of a chimney in which a strong fire is burning is supplied in part by the air which has passed through those places, thus introducing into the living-rooms unpleasant and unwholesome odors.

5. *Heating effect of ordinary fire-places.*—The hot air from the fire passes out of the chimney at a temperature often at 140°, 175°, 212°, or more. It carries with it and diffuses in space, without useful effect, the greater part of the heat given out by the fuel. This loss is as great as six-sevenths, seven-eighths, and more, of the heat produced, so that what can be called the heating effect of an ordinary fire-place scarcely exceeds 12 or 14 per cent. of the total amount of heat produced by the fuel. It is necessary, then, while retaining the advantage of a quick change of air, to restrict the amount and the temperature of the escaping air to that necessary to maintain the healthful condition of the room and the force of the draught.

6. *Proportions necessary to secure change of air and draught.*—A common chimney of the proportions usually adopted at present in Paris removes in an hour on an average an amount which equals and often exceeds five times the capacity of the room it is intended to warm, and this change of air will be sufficient in rooms of the usual size to secure a ventilation of over 1,000 cubic feet of air an hour for each person, supposing there be more than one for every ten square feet of floor room.

Again, in order that the draught should be sufficiently strong and unaffected by the wind, it is only necessary that the products of combustion should escape with a velocity of ten feet a second in the case of a fire of average intensity; but it is unnecessary, and even injurious, to have so great a velocity in the main flue, where it should be only from three to seven feet in a second, which is secured by making the flue sufficiently large.

The theoretical discussion of the conditions of the motion of air in chimneys, and the results of experiment, lead to the following rules for the proper proportions for chimneys in dwelling-houses.*

7. *Proportions of flues and shafts for private houses.*—For dwelling-houses in the city or in the country, only a few stories high, where the walls that the flues are built in are of sufficient thickness, the chimneys may be made of common bricks, and then the proper dimensions for the flues as well as for the shafts at the top, according to the size of the room, may be determined by the table given immediately below.

It may be remarked that the dimensions of flues given for rooms with an area of 10,000 cubic feet are quite large, and that it would be difficult to exceed them without causing the great annoyance which is experienced in large flues, that of causing descending currents of smoke when the fire is kindled.

It will, therefore, be better in warming such large rooms to use a heater in addition to the fire-place.

Area of room.	Volume of air to be changed every hour.	Flues.				Shafts.			
		Sectional Area.	Rectangular.		Cylindrical diameter.	Sectional area.	Rectangular.		Cylindrical diameter.
			Length.	Breadth.			Length.	Breadth.	
Cubic ft.	*Cubic ft.*	*Sq. in.*	*Ft. In.*	*Ft. In.*	*Ft. In.*	*Sq. In.*	*Ft. In.*	*In.*	*Ft. In.*
3,532	17,658	144	1 2 9-16	9 13-16	11 1-2	72	1 1	5 1-2	7 1-2
4,226	21,189	172	1 2 9-16	11 13-16	11 3-16	86	1 2 9-16	5 7-8	8 1-4
5,296	26,487	213	1 6 1-8	11 13-16	1 1	108	1 1 11-16	8	9 7-8
6,356	31,784	258	1 9 5-8	11 13-16	1 2 1-2	129	1 4 1-8	8	10 3-16
7,769	38,847	316	1 10 13-16	1 1 11-16	1 3 3-4	158	1 7 11-16	8	11 3-16
10,382	45,910	373	1 11 13-16	1 3 3-4	1 5 5-16	186	1 11 5-8	8	1 3-16
10,595	52,973	430	2 2	1 3 3-4	1 6 1-2	215	1 11 5-8	9	1 1

8. *Proportions of flues and chimney-caps in apartment houses of many floors.*—In cities where houses are built of many stories to rent in flats, especially in Paris, chimneys are built of bricks of special forms or of pottery-ware pipes, on the top being usually placed cylindrical caps of the following dimensions:

Number of the pattern.	Diameter.	Sectional area.
	Inches.	*Sq. in.*
1	9 13-16	76
2	8 11-16	59
3	7 1-2	44
4	6 5-16	31

Three types of pottery-ware pipes may be distinguished:

9. *First type, made in sections called wagons.*—(Fig. 3.)—

FIG. 3.

They are placed in the thickness of the partition walls or in the face of the wall and forming part of it. Of these there are five different patterns or numbers, the proper one to be used depending upon the size of the rooms to be warmed and the thickness of the walls in which they are to be placed.

The number of the pattern of pipe and cap to be used may be determined by the following table:

Table of wagon-shaped pipes and caps to be used according to the thickness of walls and the size of rooms.

Capacity of room.	Thickness of walls.	Number of pattern.	Internal dimensions.		Sectional area of flue, A.	Number of corresponding cap.	Sectional area of cap, A'.	Ratio of $\frac{A}{A'}$.
			Length.	Breadth.				
Cubic feet.	*Ft. In.*		*Ft. In.*	*Ft. In.*	*Sq. In.*		*Sq. In.*	
3,532–4,944	1 7 11-16	1	1 1 1-4	8 1-4	111	1	76	1·45
2,825–3,532	1 4 1-2	2	11	8 1-4	91	2	59	1·54
2,825–3,532	1 3 3-4	3	10 3-16	8 1-4	85	2	59	1·43
2,825–3,532	1 1 3-8	4	10 5-8	8 1-4	88	2	59	1·49
1,589–2,119	9 13-16	5	7 7-8	7 1-6	51	4	31	1·78
								1·54

10. *Second type, pipes made in sections called measures, designed for chimneys which project from the wall against which they are built.*—(See Fig. 4 on next page.)

These pottery pipes are thin and have a mean height of 1 foot 9 inches. They are made in six numbers, which may be selected by the particulars given in the first table on next page.

11. *Observation.*—It will be seen that these pottery flues are only suitable for rooms of ordinary size, and would be entirely insufficient for large reception-rooms.

12. *Third type, arch shaped pipes called Gourlier's.*—(Fig. 5.)—This form of pipe is only employed for small chimneys or where stoves are used. The sections are moulded in the

* Translated for the Smithsonian Institution by Clarence B. Young.

* Essais politiques, economiques et philosophiques du Comte de Rumford, t. 1er, p. 31.

* Etudes sur la ventilation, tome 1er, chap. 5, pp. 295 et suivants.

form of voussoirs, and four are joined together to form the flue. Their thickness is usually 2¼ inches. There are only

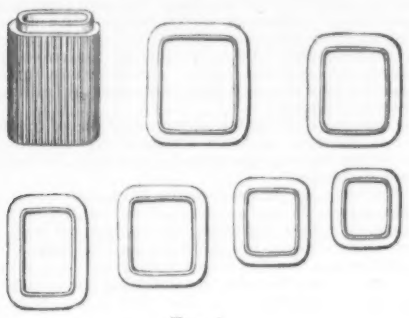


FIG. 4.

two patterns, one forming a passage of 9½ inches in diameter, or 70 square inches in area, designed for walls 1 foot 7½ inches thick; the other having an internal diameter of 8½ inches, or 59 square inches in area, used for walls of 1 foot 3¼ inches in thickness. These flues can only secure ventila-

Dimensions of pipes made in the shape of measures and of the corresponding caps to be used according to the case of the place to be warmed.

Size of place to be warmed.	Number of pipe.	Internal dimensions.		Area of flue. A	Number of corresponding cap.	Sectional area of passage, A'	Ratio. $\frac{A}{A'}$
		Length.	Breadth.				
Cubic feet.		*Inches.*	*Inches.*	*Sq. inches.*		*Sq. inches.*	
2,376-4,944	1	11, 13-16	9, 13-16	110	1	69	1.59
2,965-3,168	2	9, 13-16	8, 11-16	85	2	59	1.44
3,169-3,956	3	9, 13-16	6, 3-16	69	3	64	1.08
3,173-3,965	4	8, 11-16	7, 1-8	66	3	44	1.50
1,980-3,169	3	7, 1-8	6, 11-16	51	4	37	1.38
.....	6	6, 5-16	5, 1-8	36	.....	.....	1.36

tion in very small rooms, and should not have caps placed on them. Their use is generally limited to rooms warmed by stoves.

Fig. 5.

VENTILATING FIRE-PLACES.

13. These fire-places, the main idea of which is not new, are, like many other plans proposed by builders, intended to utilize more effectually than the common forms the heat

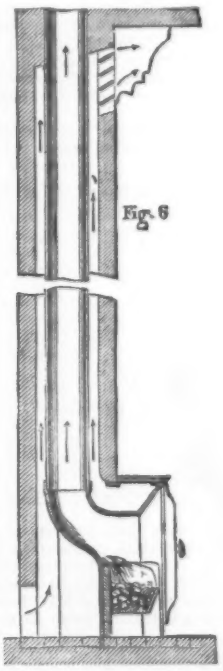


Fig. 6

given out by the fuel by introducing a considerable quantity of fresh air, warmed to a moderate degree, to replace that which has passed up the chimney, and also to reduce the amount of cold air entering from the outside through the cracks of the doors and windows. But while the plans at first proposed drew in but a small quantity of fresh air, scarcely equal to one-tenth of that passing out through the chimney, and raised it to temperatures of from 200° to 250° and often more, the forms devised by the ingenious Capt. Douglas Galton for the fire-places of English barracks have furnished a very satisfactory solution of the problem, as has

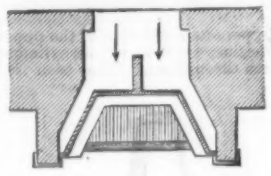


Fig. 7

been proved by some experiments made with two fire-places of this kind at the Conservatory of Arts and Trades.*

Figs. 6, 7, 8, 9, 10, show that these fire-places consist of an ordinary grate for wood or coal, completely separated from the wall behind. The fire, as far as the top of the room to be warmed, consists of a cast-iron pipe placed in

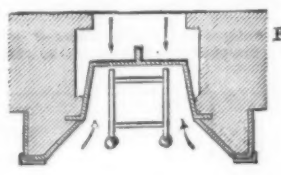


Fig. 8

the center of a shaft extending to the ceiling, and into the latter passes the external air admitted from below, on the side or at the back, according to local conditions.

Near the ceiling the shaft through which the external air has passed and been warmed contains an opening fitted with inclined slats, which direct the air toward the top of the room. This opening should contain a register, which

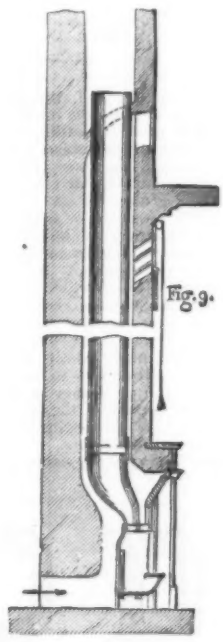
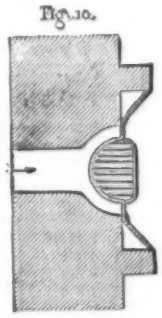


Fig. 9.

may be easily opened or closed according as the fire is bright or dull.

Observation shows that with the dimensions given below the amount of air thus introduced at 80° differs but little from that passing off up the chimney, so that the admission of cold air through the doors is almost prevented. This introduction of warm air, in addition to the warmth pro-

Fig. 10.



duced by the ordinary radiation from the fire, increases its heating effect, which becomes as much as 35 per cent. of the heat produced by the fuel, while the common forms of fire-place give but 12 or 14 per cent., and those supplied with Fondet's apparatus but about 20 per cent.

14. In every building where this form of fire-place can be used it is evident that it should be preferred to all others, and in its construction the proportions given below should be followed. (See table in next column.)

It is well to add that most forms of iron grates suitable for burning coal or coke are easily adapted to this form, provided that it be possible to provide for the admission of the external air.

Above the room to be warmed, the warm air shaft is discontinued and the flue carried up in the usual way. If, however, it be desired to use the shaft for warming rooms above, it may be prolonged; a register being fitted to it at each floor to regulate its action.

The hearths of these fire-places should be arranged as in common fire-places. They should be made of cast iron, and the fire-place lined with fire-brick if coal or coke is to be used. A movable blower should be arranged to be used for kindling the fire.

Size of room to be warmed.	Amount of air to be changed every hour.	Sectional area of smoke-pipe.	Sectional area of shaft.	Sectional area of fresh-air flue.
Cubic feet.	*Cubic feet.*	*Square inches.*	*Square inches.*	*Square inches.*
2,376	17,650	70	35	317
4,950	35,100	93	47	396
6,597	56,407	116	59	573
8,237	61,764	140	70	534
7,770	56,040	171	85	477
9,702	65,911	202	101	554
10,395	74,974	238	118	611

15. *Observations relative to large rooms.*—It is proper to repeat here that the dimensions given for these ventilating fire-places cannot be much increased, even for the largest rooms. But while two fireplaces of the usual form, placed in the same room, often interfere with each other, the same difficulty is not experienced with ventilating fire-places, which supply themselves with the necessary air for draught.

Still in such cases, it is better, in addition to the fire-places, to employ heaters, arranged according to the principles given further on, to be chiefly used in warming vestibules, stairways, corridors, anterooms, etc., only introducing into the living-rooms warm air, which has the moderate temperature of 94° to 100° in the upper portions.

STOVES.

16. *Domestic use.*—Stoves, usually placed within the room, form the most economical method of heating. Those which are made of porcelain, sheet-iron, or cast iron, without hot-air passages, and deriving their supply of air from the rooms in which they are placed, give out into the rooms they warm 85 to 90 per cent. of the heat produced by the fuel. (Fig. 11.)

Fig. 11.

Plan

But the amount of air which passes through the stove and escapes up the chimney is only about 80 cubic feet to each pound of wood burned, from 96 to 112 cubic feet to each pound of coal, and from 160 to 192 cubic feet to each pound of coke, even with a brisk fire. Stoves of this kind only produce a very slow change of air, equal, at most, to one-tenth the capacity of the place warmed, the air of which consequently would only be completely changed by them once in ten hours.

Warming by means of stoves is, then, evidently injurious to health. They have, besides, the defect of causing considerable differences between the temperatures which prevail at different heights. These differences may be as much as 18° or 20° in rooms 13 to 16 feet high.

17. *Injurious effects produced by cast-iron stoves.*—Cast-iron

Fig 12.

Plan.

stoves are much more injurious than porcelain ones on account of the great and irregular heating of their sides.

* Annales du Conservatoire, 6e volume, 1866.

They are usually so badly made that they should not be used in dwellings. According to some recent direct and careful experiments* made in 1867 by H. Deville and Troost, cast-iron, at a red heat, readily allows the passage of gas, especially hydrogen and carbonic acid, which explains the very injurious and even poisonous effects produced by the use of stoves in the rooms of a dwelling. At best, they should only be used for warming passages and such rooms in the house as are frequently opened, or in which the air may be easily changed.

Stoves made of porcelain or sheet-iron are far preferable, and are not subject to the same defects, but they do not secure a more rapid change of air.

It is proper to add, however, that, for some years back, stove-founders have been striving to improve cast-iron stoves, the imperfections of which, though not at first so well known, were still perceived. Stoves are often made at present so that after the fire is started, the opening of movable doors or the removal of blowers converts them into grates detached from the wall, and able, with sufficiently large chimneys, to produce ventilation similar to that of ordinary fire-places. In addition to these plans, many forms of which are made in foundries, if a fire-brick lining, which is easily renewed, be placed in the stoves, the excessive and sudden over-heating of the iron and the rapid destruction of the metal will be prevented, and the unpleasant effects resulting from the use of cast-iron stoves much diminished.

Similar arrangements might also be introduced into those little furnaces used at the same time for warming the room and for cooking; as well as in the construction of hot-air furnaces.

18. *Stoves with circulation of hot air.*—When the air which passes through the pipes and out through the hot air openings is taken from the room itself, the previously mentioned unpleasant effects continue, and, besides, since the air from these openings is at a temperature often above 212°, they injuriously affect the people near them, and are unhealthful.

If the hot-air passages and the draught be supplied from the external cold air, a part of the heat given out by the fuel being employed to warm this air, the heating effect of this apparatus will be slightly increased, because the escaping gases will be less warm; but it will not be less unhealthful, because the hot air which is furnished is always at an excessively high temperature.

The removal of the foul air of the room, also, is rather diminished than increased, since the temperature of the escaped gases is less.

19. *Stoves with circulation of air made on the model devised by the late René Duvoir and the General Gas-Light Company.*—These stoves, with which some schools in Paris are provided, and which are recommended to the public by the General Gas-Light Company for coke-burning stoves, utilize sixty-seven per cent. of the heat produced by the fuel.

The escaping products of combustion often have at thirteen feet from the fire a temperature of 750° or more. The warm air which passes into the room is as high as 392°, and its volume is only 800 cubic feet for each pound of coal burned, because the passages provided for it are much too small. Those of the usual proportions only produce a change of air of about 2,119 cubic feet an hour, or 352 cubic feet to the pound of coal. They are consequently unhealthful, and do not merit the name of ventilating stoves, which some makers give to them. In order to make them cheap, most stoves of this kind are made with the total heating-surface scarcely equal to twenty times that of the grate, while it should be at least three or four times as much. The surface of the hot-air passages is scarcely equal to that of the grate. This should also be three or four times as much, to increase the amount of air introduced and to reduce the temperature.

The chimney has an area equal to eighteen per cent. of that of the stove. It would be well to double it to secure at least a more rapid change of air; but then the heating-effect of the apparatus would be materially reduced.

20. *Portable heaters—Chaussenot's and similar models.*—(Fig. 13).—This builder has made, for large rooms, hallways, etc., stoves with hot-air circulation, which are true heaters, because, escaping into the air, the products of combustion pass through many pipes, and a considerable amount of warm air may be obtained, drawn, if necessary, from the outside of the building. Their heating effect is as much as ninety-three per cent. of the heat produced by the fuel. They are capable of introducing into the places to be warmed about 2,551 cubic feet of air for each pound of coal consumed, but the temperature of the air is as high as 266°, or even more, which shows that the passages are not sufficiently large. With their present proportions, they only remove ninety-one cubic feet of foul air for each pound of coal burned. They are, consequently, unhealthful, and are only suitable for warming passages, such as vestibules, stairways, etc., where the external air enters and mixes freely with the warmed air. In a stove of this kind experimented upon at the conservatory, the total heating surface is more than one hundred times the grate-surface, which is a good and large ratio. The surface of the air-passages is equal to three times the grate-surface, which is not quite enough.

The chimney has an area equal to forty-seven per cent. of the grate-surface, which is enough for draught, but does not secure a sufficiently rapid removal of foul air.

21. *Improvements to be made in the construction of stoves*—The principal defects of all stoves, without exception, are—

1. Not carrying off foul air as quickly as necessary for health.

2. Giving too high a temperature to the air which passes through them.

The means of lessening these faults are—

1. Making separate ventilating shafts, heated directly by the stove and the chimney.

2. Enlarging also the size of the hot air passages, and always, when not impossible, taking the air from the outside of the building in order to prevent it from entering through the doors and windows.

3. Furnishing the stoves with doors, which, being opened after the fire is kindled, change them almost into open fire-places, and cause a strong draught in the chimney, the size of which should be enlarged, without fear of increasing too much the expense for fuel.

German stoves and those of some French makers have an arrangement of this kind, though still imperfect.

22. *Fire-places and stoves with reversed draught.*—In some cases the want of a flue above the fire-place renders it necessary to carry the smoke to a horizontal passage below, which conveys it to the bottom of a vertical flue, placed some distance off. To obtain in such a case a draught at the instant of lighting the fire, it is generally necessary to start a small fire in an opening in the horizontal passage at the foot of the vertical flue, which causes a momentary draught; the external supply of air to this fire being stopped as soon as it is kindled, in order that, taking air from the horizontal passage alone, it may produce a current which will extend to the chimney or to the stove. But this arrangement is often insufficient, at least unless the extra fire be kept up, which would be very troublesome.

In houses lighted by gas it is preferable to introduce into the chimney at the occupied story, and not at the level of the lower horizontal passage, gas-jets inclosed in a little metallic chimney 9 13-16 inches to 11 13-16 inches high, with a separate air-supply, in order to prevent it from being extinguished by the smoke. Three or four jets, each consuming four cubic feet an hour, are usually enough. The heat given out by the combustion of gas produces in the flue an increase of temperature, which keeps up the draught

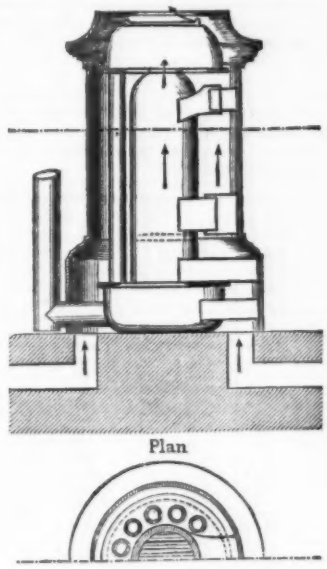


FIG. 13.

of the stoves or chimney. After the fire is well started, the gas jets may be put out. An arrangement of this kind applied at the conservatory to a stove, the draught of which could not be kept up regularly by an extra fire of the usual kind, and which was also in very bad condition, succeeded very well, even during strong winds.

STEAM-HEATING.

24. The rapid circulation of steam even under very slight pressure, and the large amount of heat it gives out in condensing, are the principal advantages of this mode of heating, which only requires, for the passage of the steam, pipes of small dimensions, but it has with the forms of apparatus most in use very grave defects.

Irregularities in the fire affect very sensibly the circulation of steam, and want of attention, especially apt to occur during the night, leads to condensation. When the fire becomes hot again, the steam, which then flows quickly into the pipes, where a partial vacuum has formed, meeting a great deal of condensed water, drives it violently, and the shocks occasionally produce explosions, often cracks and leaks, or at least very frequent disagreeable noises.

These great objections have generally led to the abandonment of warming by direct steam circulation, except in factories where the escape-steam from the engines is made use of. In that case it flows constantly through large exposed pipes, having a slope sufficient to prevent the accumulation of condensed water. But when it is designed to warm dwellings by carrying the steam through thin floors, the difficulties increase, and all the unpleasant effects become manifest.

Grouvelle, a skillful civil engineer, has designed and constructed for several hospitals an arrangement in which the steam does not directly heat the radiators placed in the rooms, but the steam-pipes heat water placed in those radiators. This system, in consequence of the great density of water and its imperfect conductibility of heat, prevents the too sudden checking of the radiation when the flow of steam is diminished or stopped. These radiators have, on top, a little opening, which prevents the temperature of the water from rising above 212°, and the pipes which furnish a passage for the air coming in from the outside do not allow the temperature of that air to exceed 104° or 113°.

Special arrangements also allow the steam to be carried through the radiators, or through external pipes, so as to moderate the temperature of the room by using only a few of the radiators. But if this plan secures a more regular warmth, it does not prevent trouble from condensation in the pipes passing through the floors, nor from leaks, which are always difficult to discover and to stop. Some accidents which have happened at Lariboisière Hospital have even shown that this system is not entirely free from sudden ruptures.

The advantages of steam-heating may be retained, without its principal defects, by arranging the circulating pipes vertically in shafts formed in the thickness of the walls, or specially built for them, as has been done in some wards of the Vincennes Hospital, or as D'Hamelincourt has arranged it for the circulation of water at the company's office at the Northern Railway.

Some of these pipes may be exposed in the form of columns, and be used for warming the hands or the feet, as is done in many establishments in Germany and Switzerland.

These arrangements, which agree very well with the condition that the fresh air should enter near the ceiling, secure the immediate return of the condensed water to the boiler, and, therefore, greatly diminish the effect of leaks, which would be more easily prevented than in the forms usually adopted at present.

Nothing should prevent the adoption, in each ward of a hospital, of an evaporator warmed by steam on Grouvelle's system, in order to promote the comfort of the patients.

It is proper to add that when the radiators and pipes have a heating surface of 215 to 258 square feet for 35,316 cubic feet capacity of halls, an elevation of temperature of 29° or 32° may be obtained even in the coldest weather. At Lariboisière Hospital the proportion is 280 square feet, and it is evidently greater than necessary. But there remains against steam-heating the charge of being too readily affected by irregularities in the fire, and particularly by want of attention on the part of the fireman, which during the night may be very much prolonged.

HOT-WATER HEATING APPARATUS.

25. This system of warming, which has been known and in use for a long time with various modifications, is much less apt to cause sudden variations of temperature than the preceding, since hot-water vessels and pipes of equal capacity always contain a much greater number of units of heat than if filled with steam. The great density of water and its steady circulation through the heater long after the fire has become low, maintain a very regular heat in spite of temporary want of attention.

The temperature of the air warmed by this apparatus is always very moderate. It is even difficult to raise it above 100° or 112° with large radiating surfaces. In this respect this method of heating is very healthful, provided that ample ventilation be maintained in addition.

It is not essential to follow L. Duvoir's plan of placing regulating-receivers in the upper part of the house to which the warm water ascends, in order to secure a sufficiently rapid circulation by the difference in the density of the high ascending and descending columns.

Heating-apparatus of this kind in use at Guy's Hospital, London, at the Sydenham Palace, and all those used in warming green-houses, prove that, provided the pipes be sufficiently large, small difference in height between the ascending and descending pipes is sufficient to maintain the circulation with even a slight difference of temperature. Another conclusive example is found in the apparatus used in warming some baths.

The hot-water circulating-pipes may be arranged to warm the air either in the lower portions, or in vertical shafts built in or against the walls, through which the outside air passes and becomes warmed by contact with the pipes.

The first arrangement, in which the pipes may be in sight throughout their entire length and placed in easily accessible places, renders leaks of little consequence, and allows them to be easily found and stopped.

The second, which is used by D'Hamelincourt, and in which hand-hole plates are placed at the top of each section, gives almost the same facility, and allows of the removal of the leakage water.

Both these plans are more cheaply applied than that which has been adopted by L. Duvoir-Leblanc, who carries the water in the thickness of the floors, and they are free from the somewhat too severe condemnation which has been visited upon the plans of that builder.

In these systems radiators may be entirely dispensed with or confined to one in each ward for the comfort of the patients.

26. *Proper proportions of heating surfaces.*—A hot-water heating apparatus does not give out as much heat as a steam-heating apparatus with the same surface. An examination of the results obtained at Lariboisière Hospital shows that a heating surface of 291 cubic feet is scarcely sufficient in very cold weather, and we think that it would be better to give to the radiators or receivers placed within the rooms to be warmed at least 323 to 344 square feet of total heating surface for that capacity of 35,316 cubic feet in places similar to hospitals.

In regard to apparatus placed in cellars and designed to warm air which is carried thence through pipes which may cool it, or into rooms not kept constantly warmed, prudence requires that the heating should be 538 square feet for warming rooms containing 35,316 cubic feet, and it is also necessary that the air should not be carried to a great distance.

In general, this system has a smaller heating capacity than that in which the water is carried in pipes or through the air passages.

But when the heater, the pipes, and the radiators are all contained in the room to be warmed, the loss from waste heat is reduced, as in the case of stoves, to that carried off by the chimney. Besides, since the heat requires to be kept moderate, this system unites the advantage of healthfulness to that of economy of fuel, and appears to me as a system of general heating preferable to the other systems employed for the same purpose.

Under these conditions, the total heating-surface might be reduced to 269 square feet for heating rooms of 35,316 cubic feet.

A regular moderate and constant temperature being much better secured by a circulation of water that can be increased, checked, or even stopped, partially or entirely, as well as in the systems making use of steam, we believe that it should generally have the preference, but especially in the case of hospitals.

27. *Heating by the circulation of water of very high temperature.*—In regard to that system of heating by the circulation of water of high temperature known under the name of Perkins's system, where the water often attains a temperature above 572°, it cannot, without danger, be caried through pipes placed in the thickness of the floors or near pieces of wood, which would be slowly affected by so high a temperature and disposed to spontaneous combustion, as more than one fire has shown. Also, at present, in establishments where this system of warming has been adopted, all the pipes are in full view, and hung against the walls or ceilings, which makes a very unpleasant appearance. It is, besides, essential to surround with a grating or case those portions of these pipes which are in contact with the building in order to prevent serious accidents. On all these accounts we do not think it proper in any case to make use of this system of heating.

28. *Combination of hot water and hot-air heating apparatus.*—The difficulty of heating by means of a hot air furnace to a greater distance than 40 or 50 feet horizontally from the heaters may be overcome, as we have said before, by placing in the furnace, either a boiler or tubes, called bottles, leading into the hot-water pipes communicating with the radiators and the return-pipes. In this way a combined system of heating is obtained, one part by warm air and the other by warm water, the latter being capable of useful effect at a great distance.

29. *Combination of warming and ventilation.*—Apparatus for heating by steam, hot water, and by both air and water may easily be connected with arrangements for direct ventilation; water or steam vessels being placed in the pipes or in the chimney to give it the proper activity.

30. *General conclusions from experiments on heating apparatus made in* 1865-'66.—Experiments, the results of which I have given in notes appended to the Annals of the Conservatory, together with those which I have already published on fire-places, lead to the following classification of the different forms of heating apparatus examined, made with reference to their heating-effect; that is, the ratio of the heat which they give out directly or indirectly in the places for which

* Comptes Rendus de l'Académie des Sciences, 13 janvier, 1868.

they are intended to that developed by the fuel consumed. The table also shows their advantages and defects as regards ventilation and effect on health:

Classification of heating-apparatus in regard to heating effect.

Forms of apparatus.	Percentage of heating effect.	Remarks.
Ordinary fire-place	10-13	Carry off foul air but do not directly bring in fresh air. Effect of system healthful.
Ventilating fire-place	19-35	Carry off foul air and directly introduce moderately warmed fresh air. Healthful system of heating.
Common stoves, without circulation of air.	Coal iron, burning { Coal / Coke	30 / 60
	Porcelain, burning wood, slightly healthful	67
Metal stoves, with circulation of air taken from the outside of inside.	Mouth to use in schools in Paris	60
	With vertical pipes, Chaussenet's model	67
Registers with pipes for circulation of hot air.	Horizontal	63
	Vertical	80
Apparatus for circulation of hot water.	When the pipes and radiators are very numerous with large surface compared with that of the heater	65-75
	When the boiler, furnaces, and all the radiators or pipes are contained in the place to be warmed	85-90
	Easily adapted for the establishment of large direct ventilation.	

VENTILATION.

GENERAL PRINCIPLES.

31. *Properties of air.*—Before giving the rules to be followed and the propositions to be adopted to secure in dwellings a proper change of air, it will be useful to state some general principles of physics relative to the properties of this gas.

Air, composed of 21 per cent. of oxygen and 79 of nitrogen, is a ponderable body. At the temperature of 32°, and under the pressure of 30 inches of mercury, 1,000 cubic feet of air weighs 1¼ ounces. It is subject, then, like all other bodies, to the laws of gravity. Its molecules, like those of all gases, are but feebly bound to each other by molecular attractions; the slightest force, the least elevation of temperature, the feeblest reduction of pressure, causing the preponderance of the repulsive forces and separating the elements from each other. On the contrary, the slightest depression of temperature unites more closely the molecules of air, and renders it more dense and heavy.

Air expands under the action of heat and contracts under that of cold, the same as other gases, and its volume varies with the temperature, according to Gay-Lussac's law, expressed by the formula—

$$V=[1+0{\cdot}002036\,(t-32)]\,V_0=[1+a\,(t-32)]\,V_0$$

in which—

V_0=its volume at 32°, and at the barometric pressure of 30 inches of mercury.

V the volume which it occupies at the temperature t_0; and

a=0·002036=a constant coefficient obtained by experiment, and which expresses the proportion in which the volume increases for each degree Fahrenheit.

This formula shows that, under the same barometric pressure, a volume of one cubic foot of air at 32° becomes—

$$[1+a\,(t-32)]=[1+0{\cdot}002036\,(t-32)]$$ cubic feet in passing to the temperature of t degrees.

If the temperature falls instead of rising, the air contracts, its volume diminishes in cooling, and it follows in this contraction the same law, expressed by the formula—

$$V=[1-0{\cdot}002036\,(t-32)]\;V_0=[1-a\,(t-32)]\,V_0$$

which is the same as the preceding formula if the temperature t is considered plus when above zero and minus when below.

32. *Variation of density.*—When the temperature of the air rises and its volume increases, its density, or the weight of a cubic foot, diminishes according to a law expressed by the following formula, assuming that the atmospheric pressure remains constantly equal to that of 30 inches of mercury:

$$d=\frac{d_0}{1+a\;(t-32)}=\frac{0.081}{1+0{\cdot}002036\,(t-32)}$$

The density or the weight of 1 0·0 cubic feet of air at different temperatures, calculated by the above formula, is given in the following table:

Temperature by Fahrenheit's thermometer.	Weight of 1,000 cubic feet.	Temperature by Fahrenheit's thermometer.	Weight of 1,000 cubic feet.	Temperature by Fahrenheit's thermometer.	Weight of 1,000 cubic feet.	Temperature by Fahrenheit's thermometer.	Weight of 1,000 cubic feet.
°	Lbs.	°	Lbs.	°	Lbs.	°	Lbs.
—4.0	.0875	64.4	.0760	132.8	.0673	201.2	.0603
—0.4	.0860	68.0	.0755	136.4	.0669	204.8	.0600
3.2	.0861	71.6	.0751	140.0	.0665	208.4	.0597
6.8	.0855	75.2	.0748	143.6	.0661	212.0	.0594
10.4	.0849	78.8	.0741	147.2	.0657	215.6	.0591
14.0	.0842	82.4	.0736	150.8	.0653	219.2	.0587
17.6	.0836	86.0	.0731	154.4	.0649	222.8	.0584
21.2	.0829	89.6	.0726	158.0	.0646	226.4	.0581
24.8	.0824	93.2	.0721	161.6	.0642	230.0	.0578
28.4	.0819	96.8	.0716	165.2	.0638	233.6	.0575
32.0	.0811	100.4	.0712	168.8	.0634	237.2	.0572
35.6	.0803	104.0	.0708	172.4	.0631	240.8	.0569
39.2	.0799	107.6	.0703	176.0	.0628	244.4	.0566
42.8	.0794	111.2	.0699	179.6	.0624	248.0	.0563
46.4	.0788	114.8	.0694	183.2	.0620	251.6	.0561
50.0	.0783	118.4	.0690	186.8	.0616	255.2	.0558
53.6	.0777	122.0	.0686	190.4	.0613	258.8	.0555
57.2	.0771	125.6	.0681	194.0	.0610	262.4	.0552
60.8	.0766	129.2	.0677	197.6	.0606	266.0	.0549

33. *Mariotte's law.*—According to this familiar law, the temperature of the air remaining constant, its volume varies inversely as the pressure to which it is exposed, and its density is proportional to those pressures.

34. *General relation between the pressure, volume, temperature, and density of air.*—Calling—

d_0, V_0, P_0, the density, the volume, and 32 degrees,
d, V, P, the pressure corresponding to $(t-32)$ degrees,
d', V', P', to the temperatures, $(t'-32)$ degrees,

the following relations result from the combination of Mariotte's and Gay-Lussac's laws:

$$V=V'\frac{[1+0{\cdot}00.036\,(t-32)]\;P'}{[1+0{\cdot}002036\,(t'-32)]\;P}$$

$$d=d'\frac{[1+0{\cdot}002036\,(t'-32)]\;P}{[1+0{\cdot}002036\,(t-32)]\;P'}$$

If we suppose that $t'=0$ and $P=P'=$ one atmosphere, $d'=0{\cdot}081$ pound, the last formula becomes—

$$d=\frac{0{\cdot}081}{1+0{\cdot}002036\,(t-32)}$$

which has been found before.

(To be continued.)

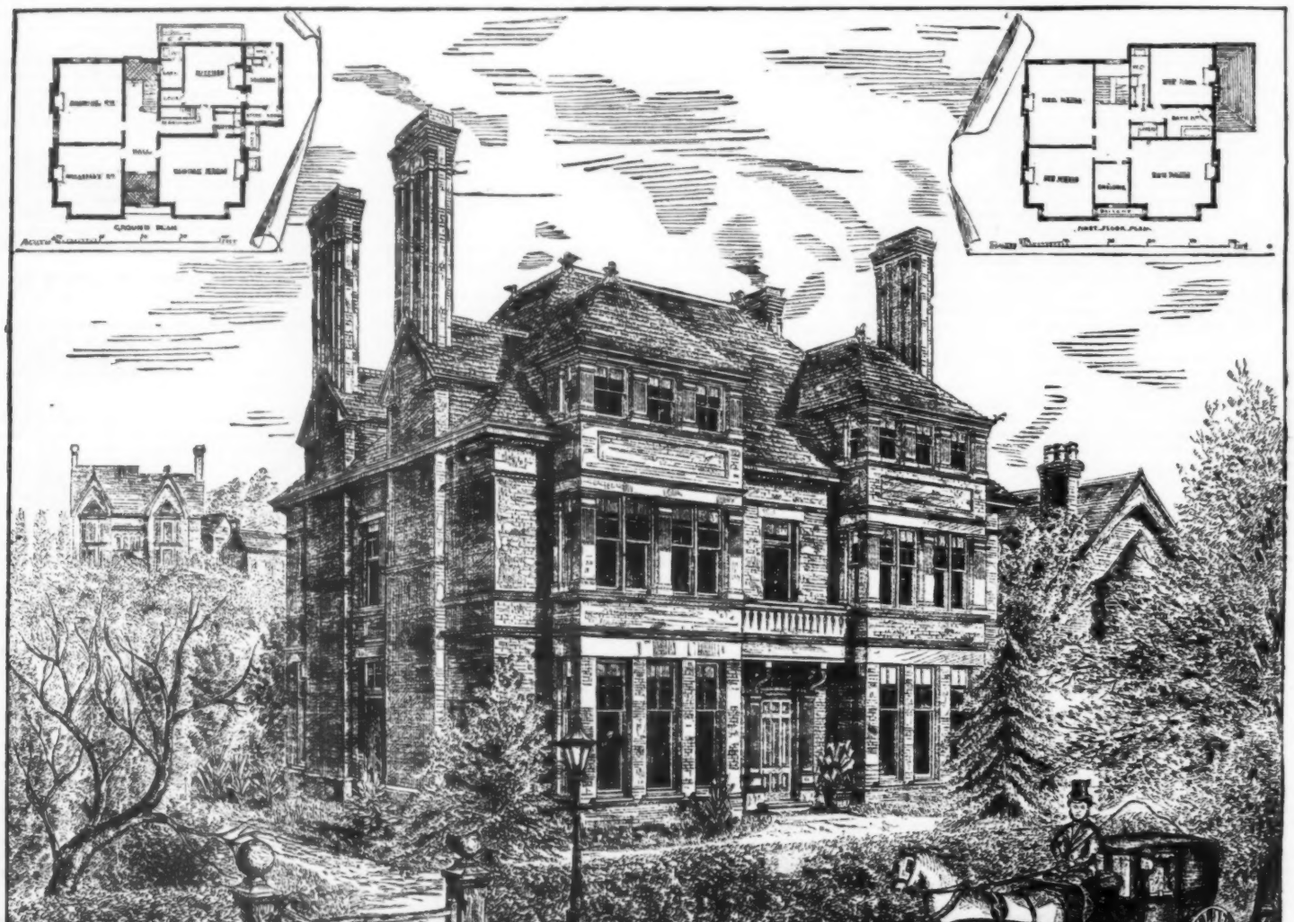
ASPHALT AND ITS COMMERCIAL VALUE.

Asphalt, on account of the high value it has in the market, is often adulterated with coal-tar pitch. Formerly its purity was determined by testing its elasticity or determining the depth to which a weighted iron point would penetrate. These, however, are unsatisfactory for practical determinations. A new method proposed by H. Hauschild is as follows: One gramme, which has previously been heated up to 200°, is shaken up with five cubic centimeters of alcohol. If the solution contains only two per cent. of pitch, it will show a distinct yellow to green fluorescence, which becomes more intense as the percentage of pitch increases.—*D. Topf. and Zgl. Ztg.*, 12, 401.

In order to accumulate electricity for the production of the electric light, M. J. Rousse has arranged secondary batteries which differ from those of M. G. Planté. At the negative pole he places a sheet of palladium, which, during the electrolysis absorbs more than 900 times its volume of hydrogen. At the positive pole he uses a sheet of lead. The electrolyzed liquid is sulphuric acid at 0·1. This element is said to be very powerful even when of small dimensions. Another secondary element which has also given good results is formed at the negative pole of a slender plate of sheet-iron. This plate absorbs more than 200 times its volume of hydrogen when electrolyzed in a solution of ammonium sulphate. The positive pole is formed of a plate of lead. Both these batteries were previously noticed briefly.

HOUSE AT HOLLY PARK.

Huntly Lodge, the subject of our illustration, was recently erected in Holly Park, Crouch Hill. The cost was about £3,000. The house is substantially built and faced all round with red Suffolk bricks. Selenitic lime was used for mortar and plastering; the dressings are of red Corsehill stone; the reception rooms are fitted with heavy wainscot doors and parquet margins to floors; the staircase is constructed in walnut and pitch pine, and a raised panel wainscot dado runs round the hall and staircase; the surbase moulding forming the door architraves; the hall is laid with solid parquet flooring; the whole of the woodwork is painted in party colors and varnished.—*Building and Engineering Times.*



SUGGESTIONS IN ARCHITECTURE.—HOUSE ERECTED AT HOLLY PARK, CROUCH HILL.—W. WAYMOUTH & SON, ARCHITECTS.

DR. W. B. CARPENTER, M.D., LL.D., F.R.S., ETC.

WE do not limit the application of Tennyson's "wise who reign" to kings, monarchs, or the governors of states, but regard it in its broader acceptation, placing in the first rank those who reign in the realm of mind. And among the choice minds of the present century, the toilers in the fields of scientific research and biological investigation, Dr. W. B. Carpenter occupies an exalted position. Belonging to a family famous in more than one sphere of philanthropy and usefulness, he is its most distinguished member; while his high scientific attainments have been made subservient to his endeavors to instruct, elevate, and refine his fellows.

Dr. William Benjamin Carpenter, C.B., M.D., LL.D., F.R.S., F.G.S., etc., late registrar and still member of the senate of the London University, son of the late Rev. Dr. Lant Carpenter, of Bristol, the celebrated theologian and philanthropist, was born at Exeter, October 29, 1813. His brother, the late Rev. P. P. Carpenter, of Montreal; and his sister, the late Mary Carpenter, were both indefatigable social reformers, chiefly directing their efforts to the instruction of the ignorant and the elevation of the fallen.

Mr. W. B. Carpenter received his medical education partly in Bristol and subsequently in London and Edinburgh. In 1832 he accompanied Mr. Estlin to the West Indies, where, after residing four months in the Island of St. Vincent, he visited Granada. Returning home he resumed his studies at Bristol, and in 1834 entered University College, London, shortly afterward becoming clinical clerk to Dr. (now Sir) Thomas Watson.

In 1835, having passed his examinations at the College of Surgeons and Apothecaries' Hall, he proceeded to Edinburgh, where he studied physiology under Dr. Alison, and materia medica under Dr. Christison. He also joined the Royal Medical Society, and in the following year was elected

W. B. CARPENTER, M.D.

one of its first presidents. In 1837, as president, he delivered the Centenary Commemoration Oration. In the summer of that year he returned to Bristol, where he entered upon the general practice of medicine, and accepted the position of Lecturer on Medical Jurisprudence to the Bristol School of Medicine, devoting his leisure hours to scientific pursuits. Mr. Carpenter took his M.D. degree in Edinburgh in 1839, an alteration in the rules of the university enabling him to do this by a three months' additional residence there.

A paper by Dr. Carpenter on the "Voluntary and Instinctive Actions of Living Beings" was published in the *Edinburgh Medical and Surgical Journal* in 1835, and in 1837 appeared his first contribution to the *British and Foreign Medical Review*, then edited by Drs. Forbes and Conolly. In the same year he took the students' prize of £30 for an essay, and appropriated the money to the purchase of a microscope. From that time microscopic investigation became one of his leading pursuits. In 1838 he published the first edition of his famous treatise on "Comparative Physiology," the plan and execution of which at once stamped him as possessing in an extraordinary degree the faculty of selecting and systematizing scientific facts.

In 1840 Dr. Carpenter relinquished the practice of medicine, and devoted himself to scientific and literary work, and in the following year he issued a second edition of his first work and published his "Principles of Human Physiology." In 1844 he removed to London, and became Fullerian Professor of Physiology in the Royal Institution. In 1845 he became a lecturer on anatomy and physiology at the London Hospital; and in 1847, examiner in physiology and comparative anatomy in the University of London, a position he held until May, 1856, when he was elected registrar to the University. In 1849 he was appointed Professor of Medical Jurisprudence at University College.

The other principal writings of Dr. Carpenter are: "Mollusca, Crustacea, and Echinodermata," in 1845; "The Microscope and its Revelations," in 1856; "Varieties of the Human Race," in 1860; and "Principles of Mental Physiology," in 1874.

Dr. Carpenter's great works have gone through numerous editions. He has contributed largely to the leading medical, scientific, and literary reviews. He edited the *British and Foreign Review* from 1847, when he succeeded Dr. Forbes, until 1852. In 1850 he gained a prize of £100 given for an essay on temperance, which was published as the "Physiology of Temperance," and had a very extensive sale. He has written much on mesmerism, electro-biology, and other psychological topics, and lectured extensively to popular audiences on subjects calculated to aid the intellectual and moral improvement of the people. Of his works on physiology, Sir Benjamin Brodie declared at the annual meeting of the Royal Society, in 1861, that they had "served more, perhaps, than any others of their time to spread the knowledge of those sciences, and to promote their study among a large class of readers."

Dr. Carpenter was elected president of the British Association when that important body met in Edinburgh, in 1871; and at the same time the honorary degree of LL.D. was conferred upon him by the Edinburgh University. He was created C.B. in 1875, and he has received many other marks of distinction. He is associated with the chief learned and scientific societies and bodies at home and abroad; and the papers he has communicated to them on important scientific and social questions form valuable contributions to the scientific literature of the age.

In May, 1879, in order to devote himself to original scientific research, Dr. Carpenter resigned the registrarship of the London University, relinquishing the emoluments of the position. His services to that institution were fully recognized by its senate and graduate body, who subscribed for a presentation portrait of Dr. Carpenter, which now hangs in the senate-room of the university. Dr. Carpenter is still busy, and rarely a month passes without the appearance of an article or paper from his pen. He is now engaged on important biographical work relating to some of his scientific contemporaries; but he still finds time for giving an occasional popular lecture, and for co-operating with efforts devised to promote the common weal.—*House and Home.*

IODINE IN COD-LIVER OIL.*

By M. MITCHELL BIRD, F.C.S.

THE author said that according to one section† of observers iodine is found in all true cod-liver oil; according to another‡ it is not a constant constituent; while a third§ has failed to find it at all.

The principal method made use of by the author in his experiments consisted of saponifying the oil with alcoholic solution of potash, carbonizing the resulting soap, exhausting the residue, acidifying the resulting solution with hydrochloric to obtain an appreciable amount of palladium iodide. In this manner he estimated samples of oil to which known quantities of iodide of potassium had been added, and then attempted to obtain an appreciable amount of palladium iodide from various quantities of different samples of cod-liver oil, but without success.

He then determined to endeavor to estimate any iodine present in his samples of oil as iodide of starch, by color comparison with solutions containing known quantities of that substance. In order to test the value of this method he made the following solutions:

Solution A measured 5,000 grain measures and contained iodide of potassium in the proportion of 1 part in 10,000 of water.

Solution B measured 5,000 grain measures, and contained (besides iodide of potassium in the same proportion as A) carbonate of potassium, free from iodine, similar in quantity to what would result from the carbonized residue of 5,000 grains of cod-liver oil which had been saponified with caustic potash.

Solution C.—This solution was prepared by dissolving 1,250 grains of carbonate of potassium, free from iodine, in distilled water, and adding 0·5 gr. iodide of potassium.

To solution A, he added a few drops of solution of nitrite of potassium, starch liquor in excess, and dilute sulphuric acid.

To solution B, dilute sulphuric acid was added until the solution was slightly acid, and set aside for two or three hours, filtered, and the deposited sulphate of potassium washed upon the filter with a small quantity of distilled water; to the filtrate solution of nitrite of potassium and starch liquor were then added.

C.—This solution was evaporated to dryness; the residue from the evaporating dish was carefully removed, and rubbed into a thin paste with rectified spirit; the mixture returned to the evaporating dish and boiled with successive portions of rectified spirit; the solution filtered and the residue washed on the filter with spirit; water added to the filtrate and evaporated nearly to dryness; more water added and evaporated to dryness; the residue dissolved in water; filtered; the filter well washed with water, and to the filtrate solution of nitrite of potassium, starch liquor and dilute sulphuric acid were added.

These solutions (A, B, and C) were then diluted until when stood upon a sheet of white paper their depth of color could be easily compared, either in the white stoppered bottles in which they had been placed, or in Nesslerizing tubes; they were equal in depth of color.

Solution D measured 5,000 grains, and contained iodide of potassium in the proportion of 1 part in 100,000 of water.

E contained the same proportion of iodide of potassium as solution D, and carbonate of potassium free from iodine, similar in quantity to what would be found in the carbonized residue from 5,00 grains of cod-liver oil which had been saponified with caustic potash.

F contained iodide of potassium in the proportion of 1 part in 1,000,000 of water.

G contained iodide of potassium in the same proportion as F, with addition of carbonate of potassium, as in the previous cases.

To solutions D and F the starch test was applied at once; solutions E and G were treated by acidification, separation of sulphate of potassium and application of the test for iodine, as before.

Solutions D and E, containing 1 part of iodine of potassium in 100,000, were made up to an equal bulk and compared; the depth of color of the two solutions was equal; the color of solution D, however, approached nearer to violet than solution E.

Only a very faint reddish tint was developed in solutions F and G, containing 1 part of iodide in 1,000,000.

From these experiments the author inferred that the quantity of alkaline sulphate remaining in solution after acidulation with sulphuric acid and separation in the manner described, was not sufficient to interfere to any appreciable extent with the color developed, and that exhaustion with rectified spirit and estimation of the iodine from the spirituous extract has no advantage over this method.

The author now proceeded to estimate the iodine in the following six samples of cod-liver oil. In each case 5,000 grains of oil were taken and saponified with alcoholic solution of potash, containing as much caustic alkali as would theoretically be required to saponify that quantity of cod liver oil, reckoned, for the purposes of these experiments, as 95 per cent. oleine, by stirring together and heating over a water-bath for six hours, removing the whole arrangement from the fire, and setting aside until a solid mass of soap had formed. He then projected this mass, a portion at a time, into a large crucible placed in a stove. When the mass had been sufficiently burnt the crucible was removed from the fire and allowed to cool; the residue was then lixiviated with water, the undissolved portion thrown upon a filter and washed until the washings ceased to be alkaline to test paper. This filtrate was then concentrated considerably by evaporation. When quite cold, it was slightly acidulated with dilute sulphuric acid and set aside for two or three hours, filtered, the sulphate of potassium washed upon the filter, and the precipitate allowed to drain. To the filtrate a few drops of solution of nitrite of potassium and an excess of starch liquor were then added, and if necessary, more dilute sulphuric acid.

Solutions containing known quantities of iodide of potassium were prepared and compared with the solution obtained from the cod-liver oil residue, both being diluted equally, and of such bulk as would allow of easy comparison. After the solutions had been compared a first time, they were set aside in stoppered bottles until the iodide of starch had completely subsided, when more starch solution was added and the solutions again compared.

The following six samples of cod liver oil were purchased from first-class London houses, but beyond speaking positively as to the place of their preparation, they could give very little information concerning them.

Sample No. I. was a pale oil prepared in Norway, very little sensitive to cold, and having—for cod-liver oil—quite a pleasant flavor. The amount of iodine calculated as KI yielded by it was 0·105 gr., or 0·21 part in 10,000.

No. II.—This was a pale Norwegian oil of ordinary quality, having a flavor not quite so delicate as the preceding, and more sensitive to cold. The iodine calculated as KI yielded by it was 0·09 gr., or 0·18 part in 10,000.

No. III. was a light-brown Norwegian oil, with a more decided and less pleasant flavor than the preceding. It yielded 0·08 gr. of iodine calculated as iodide of potassium, or 0·16 part in 10,000.

No. IV. was a sample of light-brown, much puffed oil, said to have been prepared in Norway. It yielded 0·08 gr. of iodine calculated as KI, or 0·16 part in 10,000.

No. V.—This was a pale oil, prepared in Newfoundland, very free from smell and flavor, but very sensitive to cold. It yielded 0·06 gr. of iodine calculated as KI, or 0·12 part in 10,000.

No. VI. was a Newfoundland oil of a light-brown color, and strong flavor. It yielded 0·07 gr. of iodine calculated as KI, or 0·14 part in 10,000.

From these experiments it seems probable, the author remarks, that iodine is a constant constituent of cod-liver oil, but that it is not present in quantity at all approaching 0·05 per cent., as has been stated; the amount of iodine yielded by these oils being in inverse proportion to their sensitiveness to cold.

Professor Redwood said that this subject of the quantity of iodine in cod-liver oil had been discussed in that society from time to time ever since cod-liver oil had been used as a medicinal agent. From the experiments of Mr. Bird, it appeared, as they would all be ready to agree, that the starch test was by far the most delicate one for indicating the presence of iodine in the oil. It was somewhat remarkable that while some experimenters had found iodine in small

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* Abstract of a paper read at an Evening Meeting of the Pharmaceutical Society, February 1, 1882.

† De Jongh, Garrod, and others.

‡ Bentley and Redwood, Chevallier and Gobley, Herberger and others.

§ Ure, Marder, and Kümmell.

quantities by the starch mode of operating, others had failed to do so. The observations made by Mr. Carles seemed to indicate that when iodine was found in cod-liver oil, it resulted from a portion of the matter of the liver of the oil being diffused in the oil. That seemed to be a point that now called for the attention of investigators. Probably all would agree that the small quantity of iodine which had been found, even where the iodine existed in the largest quantity, could not be assumed to be the active principle upon which the efficacy of cod-liver oil depended.

Mr. Groves had always regarded the efficacy of cod-liver oil as depending upon the biliary matters of the fish. It was a curious fact that curriers would not use any other oil than liver oil. They found that the oil of the liver penetrated the leather better than any other sort. He thought that cod-liver oil depended for its efficacy upon its power to penetrate the tissues of the body. Perhaps the search for iodine in cod liver oil might be conducted somewhat in the same way as the search for sulphur in gas. The oil might be burnt and the vapors condensed. The whole of the iodine might then be obtained.

Dr. Symes said that it would be desirable to try some oil prepared from Scotch cod, and find whether it contained a larger proportion of iodine than that obtained from the English cod. He believed that it was a recognized fact that kelp prepared from the weeds on that part of the coast near the Gulf Stream, yielded a larger proportion of iodine than that made from other seaweeds, and possibly the fish in such a locality might yield an oil containing more iodine. He had been assured by a medical man, whose experience extended over forty years, that the presence of iodine in cod-liver oil had really nothing to do with its medicinal efficacy; neither did he credit its efficacy to the presence of the biliary matters of the fish. This gentleman suggested that cod-liver oil and several other oils should each be emulsified with mucilage or some other substance, and that a drop of each emulsion should be placed under the microscope. He (Dr. Symes) performed the experiment as suggested, and he found that cod-liver oil formed a much finer emulsion than the other oils, and that the globules of oil were much finer. The medical man who suggested the experiment attributed the absorption and efficacy of cod-liver oil to the fact of these globules of this oil being smaller than those of other oils, hence it became more completely emulsified in the stomach, and more readily taken up by the system.

Mr. Holmes remarked that the information afforded by Mr. Bird's experiments on the cod-liver oils most largely used in commerce was more useful than the information which would have been afforded by experiments on oil made in England, which was not so largely used, and which, he believed, was not invariably prepared from the livers of the cod alone.

DEAFNESS IN THE SCHOOLS.

THE FIELD OF INQUIRY OPENED BY DR. SAMUEL SEXTON, OF THIS CITY.

SOME months ago, in noticing some recent investigations as to the dental transmission of sound, reference was made in the *Times* to a new field of inquiry opened by Dr. Samuel Sexton, of this city, relative to the prevalence and causes of partial deafness among the pupils in our public schools. Dr. Sexton, during a series of examinations, has amassed a fund of valuable information and statistics. He has collected a curious cabinet of casts, numbering several hundred, illustrating different departments of the subject, which has been regarded of sufficient importance by the Bureau of Education at Washington to justify the publication of a special circular under the auspices of the Department of the Interior. It is a familiar fact that, of late years, the prevalence of nearsightedness in public schools and higher institutions of learning has commanded the attention of some of the ablest specialists of the world in diseases of the eye, among them Dr. Agnew and Dr. Loring in this country, and Dr. Cohen in Germany. The public schools of this city, Boston, Cincinnati, and other large centers of population in the United States, and those of Vienna, Berlin, and St. Petersburg, have been carefully surveyed with reference to defective vision, the results classified by ages and conditions of life, and the causes pointed out. But the considerable prevalence of deafness disclosed by the inquiries of Dr. Sexton—scarcely less important in its relation to practical life and the future of the pupil—appears to have remained unsuspected by medical practitioners. One of the leading causes of impaired hearing in our public schools led to the collection of the cabinet of casts mentioned, comprising plaster facsimiles of the interior of the mouth in several hundred cases. This cause Dr. Sexton designates dental irritation. Its activity is principally observed between the ages of six and twelve years, during which period the development of the permanent teeth is begun and completed, and the temporary teeth are replaced by those that will continue during life. When the wisdom teeth, which generally appear at the age of eighteen, are delayed in their development, extreme irritation of the delicate structures of the ear often follows. This factor is, however, a very subordinate one in causing defects of hearing, while the development of the first set, which takes place before the school age commences, although a frequent cause of permanent deafness more or less complete, has no relation to school hygiene, however important to parents and to the family physician.

The rule that Dr. Sexton has found to apply to impaired hearing—that, owing to intimate nervous relationship, irritation of the teeth is a prolific cause of disturbance and disease of the ear—applies equally to impaired vision, and accounts for many eye and ear affections that were formerly attributed to other causes or left unexplained by medical men. "Indeed," says Dr. Sexton, "a morbid action is often set up in the ears and continues for a long time without being attended by any marked pain in either the teeth or the ears." Thus permanent disease of the latter, due to defective teeth, has often supervened and made considerable progress before any warning is received either by the parents, the patient, or the family physician. The process is accompanied by no pain in these cases, and even when drilled daily in the class room of a public school a pupil may be partially deaf of one ear, or slightly so in both, without detecting it. In the course of an examination that embraced 570 pupils this fact became strikingly apparent. The distribution was as follows:

In the colored public schools	261
In the Roman Catholic parish schools	226
In the white public schools	83

Although the examination was by no means exhaustive, the test questions being put by the instructors themselves, to whose voices the pupils were accustomed, seventy-six cases of impaired hearing in one or both ears were detected. This was about thirteen per 100. Out of these seventy-six cases, only nineteen were aware of any aural defect, although 178 recollected having had trouble of the ear at different times. The teachers were even less well informed than the pupils, and had they been called upon to report the condition of their charges in this particular would have recorded but one case of deafness. The colored pupils were all from Grammar School No. 3, varying in age from seven to thirteen. Grammar School No. 35 was taken as a fair representative of our public schools at large, and the parish school of the Church of the Assumption as an example of its class. The examinations did not embrace a sufficiently large number to admit of generalizing with statistical exactness, and in discussing their bearing the examining physician had recourse to the notes accumulated by a long experience in hospitals as an aural surgeon. The standard of normal hearing in such an inquiry was necessarily one of the first questions that addressed itself to Dr. Sexton at the outset of his work. Normal hearing is defined by him as the mental perception of sound transmitted through the unimpaired medium of both ears. When a person's hearing is defective in one ear only the fact is shown in diminished capacity to tell from what direction a sound comes and to distinguish the finer shadings in the pronunciation of words.

The standard of sensitiveness to sound which the doctor regards as most practicable for public school investigation may be expressed in a sentence. When the pupil is unable to understand what is said to him in an ordinary voice at a distance of five feet, he would place him in the category of persons whose hearing is defective, and when unable to distinguish the direction whence a sound proceeds, while able to hear with sufficient acuteness, the inference is that one ear is affected and the other normal. As a practical fact, pupils whose hearing is defective learn less rapidly than those with normal faculty, and he would hence place them in classes by themselves, where they would not be in constant competition with those possessing a material advantage over them. The rule laid down must, however, be applied with discrimination, so that bright pupils, though a little deaf, may not be mortified by removal to a separate class; for while some loss of quickness in intellectual perception generally accompanies defects of the special senses, such is by no means an inflexible law of mental life, and the task of discriminating in this respect must necessarily be exercised with discretion. Again, impaired hearing usually shows itself in some loss of distinctness in articulation (or some abnormal peculiarity in the exercise of that faculty), to prevent which more care is required than is generally given by a teacher in the class-room. This constitutes another reason for placing partially deaf pupils in classes by themselves, where they will not incur the ridicule of their classmates or be considered as feeble-minded on account of a defect that is purely superficial.

In the course of his inquiries on this subject Dr. Sexton has collected many curious and interesting notes of cases in which children frightened by autophony (hearing one's own voice in the head) have refused to speak altogether, and maintained silence until they were reputed dumb. But the most extraordinary of his cases are those in which the disease of the ear is reflex and due to defective teeth. His cabinet presents one case of special interest, representing the jaws of an English lad who had been deaf ever since he was eleven years old. The teeth of the upper jaw, which is small and shrunken, have no regularity of setting, while those of the lower are regular and overlap when the mouth is closed to the extent of eight or ten lines. Habitual mouth-breathing has arrested the development of the ear by interfering with the passage through the tubes that lead from the throat to the interior, and thus a trouble that might have been corrected by early examination has for life nearly obliterated one of the special senses and produced lasting deformity of the face. Dr. Sexton related other cases of equal interest that show the importance of the inquiry he has commenced.

THE ABSORPTION OF RADIANT HEAT.—LONDON FOG.

DR. JOHN TYNDALL, F.R.S., recently lectured at the Royal Institution, Albemarle street, on the "Absorption of Radiant Heat."

Professor Tyndall began by saying that some of the greatest superstructures of physical science depended upon a more or less ideal foundation. For instance, the undulatory theory of light could not be spiritually discerned, for the waves were far too small to be seen; it also required a mind of high ideality to conceive an ether filling all space, yet possessing the qualities of a solid. The ultimate atoms of matter stood upon the same ideal foundation. When several of these atoms were grouped together they were scientifically known as "molecules:" and the object of his address that evening was to explain the action of free molecules upon obscure radiant heat. By free molecules he meant the molecules in gases, vapors, and liquids. The invisible waves of radiant heat were longer than those of light, but inconceivably small; and there was a vast difference in the power of different kinds of free molecules to absorb these heat vibrations. They could do most in this way when they were chemically united. If a simple mixture were made of nitrogen and hydrogen gases, in the proportion of 14 to 3, and placed in a tube of wide diameter, through which a beam of obscure heat could be sent, scarcely any of that heat would be absorbed by that mixture. But if the same two gases were chemically united to form ammonia, they would stop a thousand times more radiant heat than before. It was the same with vapors. Some were as black as pitch toward radiant heat; others were highly transparent. If the number of molecules of the gas in the experimental tube were constant, the absorption of radiant heat was the same, no matter how the molecules were crowded together by the lengthening or shortening of the tube. But the molecules might further be so crowded together as to form a liquid. On trying experiments with a number of vapors, also of liquids from the same vapors, he found the mean absorption of radiant heat by the one to be 32·5, and by the other 32·9, the number of molecules being the same; so that the absorption by a liquid of its vapor is practically equal. The law is that the absorption of radiant heat remains constant through all changes between the vaporous and liquid conditions.

The speaker then stated that when impulses of light, made, say, by passing rays from the lime-light through perforations in a rotating disk, were allowed to impinge upon a small glass bulb containing vapor, sounds were given forth by the vapor, and the noise could be conveyed to the ear by means of an India-rubber tube from the mouth of the flask; the sounds were then like an ordinary organ peal, and were due to the absorption of radiant heat by each vapor tried. Some men of science had denied the accuracy of his discovery that aqueous vapor was such a powerful absorbent of radiant heat; he asked a bottle of aqueous vapor whether he was right as to its absorbent powers, and the vapor sent him a musical roar in reply. The sound was evidence that radiant heat had been absorbed.

The obscure radiation from the electric arc is eight times greater in heating power than the luminous radiation; the obscure radiation from the sun is twice that of the luminous radiation. A layer of water placed in the path of the electric light makes its radiation very much like that of the sun. Between ourselves and the sun is the aqueous vapor of the atmosphere, but at a height of 10,000 ft. or 12,000 ft. there is very little vapor in the air. Professor Langley, who was making observations in California at a height of 12,000 ft., had just written to him saying that he found a great difference in the distribution of the solar radiation at that altitude; there was an enormous expansion of the ultra-red spectrum.

HOW BITUMINOUS COAL POISONS THE ATMOSPHERE.

IN the course of a recent lecture at the Royal Institution, Professor Edward Frankland, F.R.S., said that the suspended matter in the atmosphere is mostly below the height of 5,000 ft.; probably half of it is below that level. The higher the position in the atmosphere, the smaller are the variations in solar intensity. The lower the latitude the greater might it be expected to find the intensity of the sun's rays, but this is not necessarily the case. In northern regions, coupled with the conditions of high elevation, light back ground, shelter, clear atmosphere, and a small quantity of aqueous vapor in the air, the solar intensity may be great. The chief evils of a town climate are—great heat in summer, gloom in winter, and so much dirt in the air that the colors of new or freshly painted houses soon change to a grimy hue. The darker the houses the warmer they are inside and the cooler are the streets, and more especially is this the case in relation to the roofs; slate roofs sometimes become so hot in the sun that the hand can scarcely bear to touch them, but if they were made white outside they would be as cool as the external air. All the large towns in England are near the sea level—a condition which favors air warmth, but not direct solar warmth. The combustion of coal in towns results in the discharge into the atmosphere of vast quantities of soot, tar, and steam; the more perfect the combustion, the less tar and the more steam are given off. Mr. Robert Hunt estimates that eight millions of tons of coal are consumed annually in London, and that of these six millions of tons are consumed in the winter months, consequently the amounts of steam, soot, tar, and sulphurous acid discharged into the air are enormous. Steam supplies the basis of all fog; and the fog particles become covered with tar, which renders them more permanent; dirt in the air is necessary to produce fog. To illustrate these points Dr. Frankland took a large flask containing a little vapor of water, and with air deprived of dirt by being filtered through cotton wool; on chilling this air by expansion by means of a few strokes of an air-pump, slight mist was formed which disappeared in a moment. The effects were rendered visible throughout the theater by means of a beam of light from the electric lamp thrown upon the flask. The ordinary air of the theater, with its normal charge of dirt, was then admitted into the same flask, and when the former experiment was repeated the fog was more dense and lasting then when air without dirt had been used. The presence of sulphurous acid in London air promotes fog, and the power of the acid to do so was proved by the lecturer by experiment. Tarry matter in the air renders fog more persistent by retarding evaporation. The power of tar to do so is recognized by some manufacturers, and used by them to economize fuel, while keeping water at the boiling point. Professor Frankland here exhibited one basin of water at the boiling point giving off its clouds of steam, and another basin of water at the same temperature giving off none at all, because the water was covered with a thin layer of olive oil, which the speaker stated to be the same in its influence under the circumstances as a thin layer of tar. Thus the products of combustion of our household fires, he said, furnish potent sources of fog, and it is a mistake to lay the blame on the discharges from the chimneys of manufacturers. If all manufactures were removed from London, no appreciable difference would be made in the amount of fog.

At the South Kensington Smoke Abatement Exhibition, he said, were two great classes of grates for domestic use, namely, those which burn bituminous and those which burn anthracite coal. There are about 600,000 houses in London, and little good in the way of preventing fog will be done by improved fire-grates, he added, so long as householders use bituminous coal. There is one remedy, and one only, and that is to stop the importation of bituminous coal into London. The price of anthracite coal is lower than the other, it is smokeless, and an ample supply of it and of smokeless steam coal can be had from Wales. Bituminous coal can also be rendered smokeless by coking; moreover, in the process of coking it gives off valuable commercial products. The difficulty in lighting anthracite or coke fires is overcome by Mr. Siemens' process. By an expenditure of two shillings each, every grate in London can be made to burn smokeless coal. He had proved this in his own home in spite of the grumbling of the servants at first; before they had gained experience in lighting the fires, the cost had been three shillings per grate, including blowers to facilitate lighting. The general adoption of such a system would do much to abolish the more injurious of London fogs, which always increase the death rate, more especially among persons suffering from bronchitis, asthma, and other diseases of the lungs. A cotton-wool respirator does much to prevent the choking sensation caused by London fogs, but it does not alleviate the smarting of the eyes. In any case, he added, we have little sunshine in this country, and need not make matters worse by throwing a dark unhealthy pall over ourselves.

THE TESTING OF WINES FOR FOREIGN COLORING SUBSTANCES.

TAKE a teaspoonful of the suspected sample of wine and shake it up with about twelve drops of basic lead acetate. The precipitate when brought on a piece of white filter paper will show the following colors:

With pure wine					bluish gray.
With wine colored with fuchsine					dirty violet red with reddish zone.
"	"	"	"	whortleberries	indigo blue.
"	"	"	"	elderberries	dirty green.
"	"	"	"	campeche	dirty dark blue.
"	"	"	"	carmine	dirty violet red without a zone.
"	"	"	"	red beets	
"	"	"	"	cochineal	blue.
"	"	"	"	pernambuco wood	dirty dark violet.
"	"	"	"	litmus	dirty dark blue.

—*Biedermann's Centralblatt.*, 10, 863.

RESEARCHES ON ALBUMINOID SUBSTANCES.

By M. BLENNARD.

M. BLENNARD has recently completed his investigations upon the composition of albuminoid substances. They were performed in the laboratory of Professor Schützenberger, at the College de France. The work was long and tedious, but the results were interesting, and very happily completed the researches begun by the eminent professor of the College de France on the nitrogenous albuminoid substances. Albuminoid substances when exposed to the influence of barium hydrate are decomposed and yield products which vary according to the nature of the albuminoid substances treated. A deer's horn, for example, treated with barium hydrate, becomes hydrated and produces ammonin, carbonic, oxalic, and acetic acids, and finally a mixture of amido acids. Among these latter it is important to recognize the bodies which Messrs. Schützenberger and Blenard designate as gluco-proteines. The most common of these gluco-proteines is the first member of the series, and corresponds to the formula, $C_6H_{13}N_3O_4$. There are gluco-proteines of C_8, C_7, C_9, etc., up to the highest member C_{11}. Leuceine, $C_6H_{13}N_3O_3$, occurs to the extent of about 15 per cent. of the whole mass. The following equation, according to M. Blennard, represents in a sufficiently accurate manner the composition of the total mass resulting from the action of barium hydrate on a deer's horn:

$$5C_6H_{13}N_3O_4+C_7H_{14}N_2O_4+C_8H_{16}N_2O_4+C_9H_{16}N_2O_5.$$

M. Blennard has likewise studied, by the same method, the action of barium hydrate on isinglass, osseine, gelatine, which decompose in a similar manner. Wool, feathers, human hair, give results which are comparable to those which yield albuminoid substances properly called. They differ in the quantity obtained from their total mass, in terms of equivalents slightly varied, of alanine, amido-butyric acid, etc. The fur of the rabbit acts very much like the fibroine of silk in its decomposition.

M. Blennard obtained results with legumine, beer yeast, ivory, and horse hoof, which have not yet been finished. In the second portion of his thesis, the action of bromine on gluco-proteine was studied in order to see if it was possible to decompose this body into leucines and leuceines.

On pouring bromine water into a slightly heated solution of gluco-proteine, an appreciable reaction is observed, the bromine disappears, and the formation of hydrobromic acid takes place; bromine acting in this reaction as an oxidizing agent. It may be admitted that a body is formed which M. Blennard calls oxyleuceine, $C_6H_{13}N_3O_5$, a substance which may be considered as leuceine + 2O. Thus, under the influence of bromine, gluco-proteine is decomposed into leuceine and glycocolle, with the elimination of a molecule of water. The reaction is as follows:

$$C_{12}H_{21}N_3O_8=2C_2H_5NO_2+C_6H_{13}NO_3.H_2O$$

Gluco-proteine, Glycocolle, Leuceine.

Secondly, the leuceine is oxidized by the bromine giving rise to oxyleuceine. The remaining gluco-proteines when treated with bromine yield similar reactions.

M. Blennard finished by studying in great detail the most important body, oxyleuceine, which resulted from all these chemical actions. It plays the same part in the constitution of albuminoid substances as glycerine does in the constitution of fatty bodies. Oxyleuceine is acid in its reaction, and colors litmus paper very strongly red. It is amorphous, and does not show any traces of crystallization even after several weeks. It is solid at ordinary temperatures, very soluble in water, but slightly soluble in absolute alcohol. It combines with the bases, especially with copper oxide, to form the salt, $C_6H_{14}CuN_3O_5$. With the other metallic oxides badly defined and unstable combinations are produced. Nitric acid gives a substitution product, having the probable formula, $C_6H_{12}(NO_2)N_3O_5$. On the other hand, the leuceines, when treated with nitric acid, do not produce nitrated acids. It is, therefore, probable that the molecular group is different with the leucines than it is with the leuceines.

It will be seen from this brief *résumé* that M. Blennard's investigations have not been of a sensational character, but that they are rich in facts, analyses, and observations. The subject was one of unusual complexity, and homage is due to M. Blennard for having undertaken and prosecuted with so much vigor a subject so dry and surrounded by so many difficulties.—*Revue Scientifique*, xxviii., 844.

CEMENT-BETON AND ARTIFICIAL STONE.*

A GOOD cement does not crack, and even in a northern climate is able to resist the weather, supposing it has been properly mixed. If too much water has been used, so that a glassy crust forms on the surface, and the whole mass is not homogeneous, the cement checks or cracks, and as soon as hair cracks appear moisture enters and the frost completely destroys it. A second fault is when the cement strikes out, which it ought not to do. Cement can be colored nicely and permanently with suitable colors, but quite a good deal of color is necessary if it is required to entirely hide natural color of the cement and give it the exact color desired. The addition of a coloring to cement makes it more friable and softer, so that it takes comparatively more cement than without the color. Cement is only just coming to be understood in practice, but, on the other hand, architects are too distrustful of artificial stone. For several years artificial stone for curbstones and street gutters has been made at Potsdam, and has lasted well. The gutter stones are very cleanly and neat, and the fears that frost and the pressure of the earth on both sides would destroy them have proved unfounded.

Granite, when broken up fine, imparts to cement a very considerable strength similar to gravel, but the pieces of stone being heavier settle and interfere with its manufacture. On the other hand, the addition of granite to cement without any sand makes an excellent material. In the gymnasium at Potsdam are two pillars made in this way, which support not only a cross vaulted arch, but also bear the pillars that extend to the upper story.

When marble is combined with cement without the addition of any sand, blocks are obtained of such strength that they are capable of receiving a fine polish, but cement must first assume the strength of stone. The problem was presented of building a stairs with steps 40 in. long, set into the masonry 8 in. at one end, each step having a height of 6½ in., and a total width of 14½ in. Experimental blocks were prepared, and at the end of six weeks four steps were put up for trial. Railroad iron was piled up on the steps, and the weight gradually increased until it reached 5,940 pounds. The steps held out, but no more could be put on because the masonry began to yield. The load was left on the steps for three days and nights without any injury. The steps subsequently remained unaffected. By adding pieces of marble to the cement different kinds of stone were imitated, with a saving of expense equal to nearly one-half the cost of real granite work.

A considerable quantity of cement is used for the flooring of terrace work. The manufacture of old Roman marble mosaics for parquettes and floors has rested many centuries, and has only recently been revived. The Italians make a ground bed or beton stratum from pozzuolana, or hydraulic lime, and pieces of brick, and lay the mass also in brick dust. Portland cement answers much better than these for joining the pieces of marble and such like, and can also be employed for mosaic plate and tiles.

Cement-beton—coarse gravel with cement below, fine sand with cement on top—is a pleasant and durable material used more and more every year for sidewalks and such like purposes. But many other things have been made of it—building objects, floor and cellar coverings, vaults, cattle cribs, stables, and even whole houses, as well as a series of bridges that are both good and cheap.

At a recent meeting of German cement makers one firm in Amœneburg, near Bilbrich, exhibited photographs of a bridge which they had made for the Dusseldorf exhibition, while a Frankfort firm showed the plans and pictures of another beton bridge, also at Dusseldorf. It was planned by Loehr, and the arch had a breadth of 75 ft. and a spring of only 71 in. The thickness of the arch at the counterfort was 14 in., and 18 in. at the top. The arch was constructed after the counterfort was done, April 14, 1881, by four cement workers and twenty hod carriers and helpers in eight hours. It was tested, May 25, by a one sided load on half the arch of 400 kilos per square meter, or about 80 lb. per square foot, without injury. It was then thrown open to the public, and was in use during the whole time of the exhibition.

Another firm had erected two large-story farmhouses in Lauenburg, each 166 ft. long and 76 ft. wide, with an average height of 25 ft., all of beton. The walls were 8 in. thick on the first floor, strengthened every 10 or 15 ft. with an extra thickness of 4 in. more, while the second floor had walls of only about 7 in. in thickness. The mixture employed consisted of 1 part of cement, 2 parts of sand, and 6 parts of gravel. The work occupied two months.

* From M. Von Froideville's report to a recent assembly of German cement makers, published in the *Thonindustrie Zeitung*.

LABORATORY APPARATUS FOR THE CONTINUOUS PREPARATION OF GASES.

WE represent herewith an apparatus employed at the Municipal Laboratory of Chemistry, Paris, for the continuous preparation of such gases as are frequently made use of in chemical manipulations and analyses.

APPARATUS FOR THE CONTINUOUS PREPARATION OF GASES.

It is a Sainte-Claire Deville apparatus that certain modifications have rendered more convenient and less cumbersome. To the vertical standard there is affixed on one side a horizontal support which holds the vessel containing the solid material which is to furnish the gas (sulphuret of iron, marble, or zinc, according as sulphureted hydrogen, carbonic acid, or hydrogen is to be prepared). This vessel is stationary and is provided at the bottom with a plug pierced with holes to retain the solid particles. On the opposite side of the standard, and sliding on a rack, there is a vessel for containing the diluted hydrochloric acid. This is connected with the other vessel by means of a wide rubber tube. The vessel in which the gas is produced is closed by a rubber stopper through which pass two tubes—one communicating with the pipe that leads the gases under the hood of the laboratory, and the other permitting of using the gas alongside of the apparatus.

The apparatus having been charged, is made to operate by raising the acid vessel and fixing it in the position shown in the figure. Here it is held stationary by the rack, and, if one of the cocks is open, the gas begins at once to be disengaged. To stop the operation of the apparatus, it is only necessary to close this same cock, when the accumulating gas will force back the acid and all action will then cease.

When the apparatus is not to be used for a considerable length of time, the acid vessel is lowered along the rack to the base of the standard.

To change the acid when its strength has become exhausted, it is only necessary to close the cock through which the gases issue; unfasten the clasps which hold the acid vessel in its bottom and top supports, and then to invert the vessel and empty it of its contents. The vessel is then thoroughly washed with water, refilled with acid, and fixed in position again on its supports.

GYPSUM.

THE mineral species known by the generic name of gypsum may be divided into two families, characterized by the presence or absence of water of crystallization.

The first family, of which there are several species, affords by distillation about 20 per cent. of water, and at a temperature below red heat becomes an opaque white powder.

The more important of the sub-species of this family are as follows:

1. SELENITE.—This mineral is either colorless or yellowish and grayish white, smoke gray, wax, honey, and ocher yellow, and yellowish brown; it also not unfrequently exhibits an iridescent play of colors.

It occurs in mass or crystallized. The primitive form of its crystals is a straight quadrangular prism, the bases of which are oblique parallelograms.

The fracture of selenite is perfectly foliated either straight or curved; it is divisible in three directions, of which one parallel to the base of the original prism is very well determined, and the two other lateral divisions may be obtained by gently and judiciously striking a thin lamina with any hard body; the surfaces thus discovered are, however, much less shiny than the former. The fragments are rhomboidal, specular on two surfaces and striated on the four others. When in mass it sometimes presents coarse granular or testaceous distinct concretions. It is commonly transparent, but sometimes only translucent, and has then often a disagreeable odor when rubbed. It possesses a double refraction; is so soft as to be scratched by calcium spar; is flexible in thin plates but not elastic, and is easily frangible but not very brittle. Its specific gravity is 2·26 to 2·32.

It is insoluble in the focus of the most powerful lens, nor does it yield to a blow-pipe supplied with oxygen gas if it is not laid on a charcoal support. When exposed to the common blow-pipe it undergoes little alteration if the flame is directed to the surface of the laminæ, but if the interior of the blue flame is directed on the edges of the laminæ it soon melts into an opaque white globule. Selenite abounds in France, England, Austria, Saxony, Spain, and other places.

2. FIBROUS GYPSUM.—Its color is snow white, yellowish, grayish, or reddish white, flesh red, and light hyacinth brown; several of these colors occasionally co-exist in the same specimen, forming stripes and bands. It occurs acicular and in mass, but never in very thick beds. Its internal luster varies from glittering to bright shining, with a pearly luster. It is semitransparent, passing into semitranslucent; when polished it becomes iridescent; its hardness is somewhat inferior to the preceding species and it is easily frangible and brittle. Its specific gravity is 2·3. It never effervesces with acids, and is affected by the blow-pipe like the preceding.

3. GRANULARLY FOLIATED GYPSUM OR ALABASTER.—Its color is snow white, grayish, yellowish or reddish white, flesh red, blood red, and brick red; wax yellow, smoke gray, and grayish black. Several of these colors are combined in veins, spots, and bands. It occurs massive and in blunt edged fragments. It is translucent; its luster is between pearly and vitreous, and varies, from shining to glittering. It abounds in fine and coarse granular and prismatic distinct concretions; when fine grained it often crumbles between the fingers like tender sandstone. Specific gravity 2·27 to 2·31. It generally effervesces more or less with acids on account of the carbonate of lime with which it is mixed.

4. COMPACT GYPSUM.—Its color is ash gray, passing into smoke and yellowish gray. It occurs in mass. It is translucent on the edges, is soft and easily frangible, but not very brittle, and has a dry but not very harsh feel. Specific gravity 2·3. Like the preceding it effervesces with acids.

5. EARTHY GYPSUM.—Its color is yellowish gray, passing into yellowish white or snow white. It is composed of pulverulent grains slightly adhering together; it is for the most part dull, has a harsh meager feel but is not gritty between the teeth; it stains the fingers and is easily broken down into powder. When heated a little below redness it becomes of a dazzling white; it usually gives a light effervescence with acids. It is of rare occurrence and always appears to originate from depositions made from water that has flowed over a bed of gypsum.

The second family affords little or no water by distillation, and does not become opaque and fall into powder at a temperature below red heat. Of this family there are the following sub-species:

6. ANHYDROUS SELENITE.—Its color is grayish white; it occurs in detached lamellæ or in slightly adhering foliated masses. It is translucent and possesses considerable luster. Specific gravity 2·96. It is only found in Switzerland.

7. MURIACITE.—The color of this is grayish white, grayish black, or reddish white. It occurs in loosely rectangular plates with bright specular surfaces. Its hardness is superior to common gypsum. It is weakly saline to the taste, and requires 4,300 parts of water for its solution. It was first introduced to the notice of mineralogists by the Abbé Poda, who erroneously supposed it to consist of muriate of lime.

8. GRANULAR ANHYDROUS GYPSUM.—Its color is grayish white veined with grayish blue; its luster is glimmering, its hardness is inferior to that of statuary marble, but it cannot be scratched by the nail. Specific gravity 2·87. It is moderately phosphorescent by heat, is very fusible before the blow-pipe, and effervesces strongly with acids. It is employed by statuaries for making chimney pieces, etc.

There appear to be three very distinct formations of gypsum. The oldest belongs to the class of primitive mountains, and has hitherto been only met with among the Italian Alps. It forms alternate beds with gneiss, has a schistose texture, and abounds in mica. Gypsum of the second formation rests upon floetz limestone and is disposed in beds alternating with swine-stone and occasionally with rock salt. The gypsum of this formation is mostly the compact and granularly foliated; it contains several substances embedded in it, such as quartz, arragonite, boracite, and sulphur, and most of the salt springs are found in this formation. The most recent gypsum rests upon the second sandstone formation, and alternates with indurated clay and sandstone, and is frequently covered with secondary floetz limestone. Fibrous gypsum is chiefly characteristic of this formation, and it contains, as well as the preceding, the bones of quadrupeds, but scarcely any other organic remains.

Gypsum generally forms banks and hills of little elevation in plain countries or at the mouth of large valleys. It

abounds in the neighborhood of Paris, France; in Switzerland, Italy, and the Tyrol; in Bavaria, Saxony, Thuringia, Poland, and Spain; in England, and in the State of Pennsylvania, Kansas, and other parts of the United States.

The uses of gypsum are numerous and extensive in the arts and manufactures. When it is sufficiently compact it is employed by architects for columns and other ornaments, being easier to work than marble; it is also turned on the lathe into cups, vases, and other similar articles. When exposed to a low red heat it parts with its water of crystallization and is converted into a fine white powder, like meal, called plaster of Paris; this is beaten up with water to the consistence of paste, shortly after sets and becomes solid, hence it is largely used for taking casts of various kinds and magnitudes, from a medal to a colossal statue, and it enters into the composition of many cements. It is also used in making frescoes, statuary, mouldings, etc., and is an ingredient in some of the finer kinds of hard porcelain.—*Pottery Reporter.*

CHLOROPHYL.*

By R. SACHSSE.

THE amount of chlorophyl in plants is generally much under-estimated. From 125 kilos of fresh leaves the author has obtained no less than 1·0 grammes of phyllocyanin, which he considers to be the principal constituent of chlorophyl. The numerous attempts which have been made to explain the reduction of carbonic anhydride by the green coloring matter of leaves have so far been without result, and the following hypothesis is, therefore, proposed: Chlorophyl is not the cause of the reduction of carbonic anhydride under simultaneous action of light and protoplasm, as is generally supposed, but is itself the first product of that reduction, the chlorophyl so formed being at once converted into starch and other carbohydrates, which have been usually considered to be the first products of the reduction, and its place supplied by more chlorophyl, resulting from a further reduction of carbonic anhydride. This hypothesis the author endeavors to submit to the test of experiment by trying whether pure chlorophyl can be made to yield carbohydrates by the action of reducing agents, and more especially sodium. For this purpose a quantity of fresh leaves was treated with alcohol and benzene, according to a method for which the original paper must be consulted, by which means the alcohol takes up chiefly the yellow coloring matters which accompany the chlorophyl, while the latter is dissolved by the benzene.

A solution of chlorophyl in benzene was treated with sodium, when, after a lapse of 8–14 days, a cloudiness appeared, and gradually assumed the form of a voluminous green precipitate, while the supernatant liquid was no longer green but golden-yellow, owing to the presence of a yellow coloring matter (A), which will be subsequently referred to. The green precipitate was a dark green, almost black mass, of soapy consistence, and was readily soluble in absolute alcohol, forming a brilliant green, beautifully fluorescent liquid; it also dissolved in water, forming a similar solution, but less fluorescent. On adding the solution of a metallic salt, *e. g.*, copper sulphate, to the aqueous solution, a dark green voluminous precipitate of the copper salt is obtained, while there remains in the filtrate a colorless amorphous body, which has almost the composition of a carbohydrate, but containing rather more hydrogen, and is partially converted by the action of acids into a substance showing the most important reactions of a sugar of the dextrose group. On slightly acidifying the aqueous solution of the original green or fluorescent coloring matter with hydrochloric acid, or on passing in a current of carbonic anhydride, the liquid assumes a golden green cloudy appearance, which, in the case of the hydrochloric acid, soon settles out as a distinct precipitate, while the colorless amorphous substance above referred to remains in solution. The principal constituent of the precipitate is an almost black coloring matter, to which the name phyllocyanin is given. Among the decomposition products of the original green coloring matter, by means of acids, are two substances which belong to a class of yellow coloring matters to be subsequently referred to, and another which is of a fatty nature.

The author thinks that the original green fluorescing body is homogeneous, but of a very complicated composition. On analysis, it gave, as the extremes of several determinations: 60·96–61·88 per cent. C, 9·21–9·39 H, 1·99 N, 10·46–11·00 ash (which contained sodium, phosphoric acid, and magnesium, but not iron.

Phyllocyanin, which really includes several different bodies of a very similar nature, is a dark green, almost black, mass, which is insoluble in water, only sparingly soluble in benzene, and, however prepared, is always nitrogenous. It may be separated into three different substances by treatment with hot alcohol. These gave the following composition on analysis:

	C.	H.	N.
A. Insoluble in alcohol,	67·66–67·77	8·03–8·41	5·46–5·92
B. Difficultly soluble in alcohol	69·32–69·71	6·75–7·30	8·24–8·56
C. Easily soluble in alcohol	69·14–69·70	7·45–7·60	7·08 7·30

On oxidation with potassium permanganate in alkaline solution, phyllocyanin gives ammonia, oxalic, palmitic, and probably lactic, acetic, and three other acids, which appear to be nearly related to or identical with itaconic, citraconic, and mesaconic acids.

On dry distillation under diminished pressure, phyllocyanin gives palmitic aldehyde; while on dry distillation with lime it gives palmitone, $C_{31}H_{62}O$, or possibly stearin; on treatment with bromine in aqueous solution, it is decomposed into ammonia, and, at least, three other bodies, one of which is easily soluble in benzene; the second insoluble in benzene, but easily soluble in alcohol; and the third insoluble in either solvent.

In the solid state the yellow coloring matter, A, referred to above, forms a mass varying in color from brown to yellow, or reddish yellow, of a fatty nature, always free from nitrogen, and varying in composition between 65·88–70·90 per cent. C, 7·91–9·80 H, and 26·21–19·30 per cent. O. Two other coloring matters of a pale yellow were also obtained, although it is very doubtful whether these latter were derived from the chlorophyl, or only admixed impurity; one of them had a composition represented by the formula $C_{36}H_{52}O_8$. The author considers the yellow coloring matter as the connecting link between the green coloring matters and the true fats, and is also of opinion that several modifications of chlorophyl exist, and that each chlorophyl contains a phyllocyanin, a yellow coloring matter, and a body nearly related to the carbohydrates.

* *Chem. Centr.*, 1881, 169–175, 185–191, 226–240. Reprinted from the *Journal of the Chemical Society*, January, 1882.

INDICATORS FOR ALKALIMETRY.

By PROF. E. J. HALLOCK.

IN volumetric analysis, when it is desired to determine the strength of a given acid by ascertaining how much normal alkali is required to saturate it, or the reverse, it is necessary to employ an indicator which shall mark the neutral point. It is not our design to add to the list of substances proposed for that purpose, but to enter into a critical examination of those now in use. The most common and one of the best is

LITMUS.

It comes into the market in small cubes, of a blue color, which contain an excess of alkaline carbonate. It is best prepared for use as an indicator by first extracting three or four times with strong alcohol, which removes a peculiar coloring matter that would interfere with its use as an indicator. It is then extracted with cold water, filtered, and enough acid added just to neutralize the alkali in it. It keeps its color best when left uncorked in half-filled bottles. With caustic alkalies it forms a deep blue color, that changes suddenly to an onion red when an excess of acid is added. If however, carbonates are present, the blue changes to a purple before the alkali is saturated, and the change to red is uncertain. For this reason carbonated alkalies must be titrated hot, and the liquid boiled between each successive addition of acid as the neutral line is reached. With this single drawback litmus is an excellent indicator. There are cases, however, where neutral salts (those in which all the hydrogen of the acid is replaced by metals) give an alkaline reaction with litmus. This is the case with sodic acetate.

COCHINEAL.

These are small bugs which grow on a species of cactus in Mexico. The solution is prepared by digesting three grammes of cochineal bugs (whole) in 250 c. c. of dilute alcohol, made by mixing three or four parts of water with one of alcohol. The solution is acid to litmus, and must be carefully neutralized. It has a deep carmine red color in alkaline solution, which changes to yellow when acid is added in excess. It is much better adapted to the titration of alkaline carbonates than litmus. It is not affected by weak acid, and hence cannot be used in determining acetic acid. The results obtained in titrating alkalies with litmus and with cochineal do not agree perfectly; hence the same indicator must be used in standardizing the solution as will be employed in the analysis.

CORALLINE.

This substance is easily prepared in the laboratory by heating a mixture of one part oxalic acid, crystallized, one and one half parts carbolic acid, two parts concentrated sulphuric acid, for five or six hours on an oil bath at 140° or 150° C. To prevent loss, a long upright tube may be inserted in the cork to act as a return condenser. The resulting mass is poured into water, when the coralline is precipitated as a resinous mass. It is but slightly soluble in water, yet imparts to it a deep yellow color. If enough alkali is added to this liquid to change it to a deep red, it may be used at once without purification.

To insure neutrality in the indicator and guard against possible error, the following method may be employed with this as well as other indicators: Take about 100 c. c. of water, and add to it a drop of alkali and enough of the indicator to impart to it a deep red color. Having filled the burette with one-tenth normal acid to a point somewhere *above* the zero mark, let one drop fall into this 100 c.c. solution; if it does not change add a second drop, and a third if necessary. The change is very marked and sudden. Divide this solution into two nearly equal parts in beaker glasses of the same form and size. To one add the alkaline solution that is to be tested, and to the other the same volume of distilled water; the former becomes intensely red; the other should remain unchanged. Now allow the one-tenth normal acid to flow into the red solution until its color is precisely the same as that in the other beaker glass, namely, yellow. The delicacy of this reaction is all that can be desired, and it is especially preferred to litmus for determining the strength of acetic acid, since neutral sodic acetate does not color it red. For alkaline carbonates it is inferior to cochineal, for just at the point where litmus turns purple, coralline changes to an orange, which passes gradually into yellow.

NITROPHENIC ACID

is recommended by Langbeck as an indicator. This substance, generally known as mononitrophenol, sells in Berlin at $12 per pound, and is not in the market here. It can be made in the laboratory by the action of dilute nitric acid on phenol (carbolic acid). Mix together 200 grammes of nitric acid, sp. gr. 1·340, and 400 grammes of water. The mixture has a gravity of 1·104 = 14° B. Place the vessel containing the acid in another filled with snow or ice water, and add slowly, with constant stirring, 100 grammes of crystallized carbolic acid. Pour the mixture into cold water; a heavy black oil settles beneath a red acid liquid. Separate by means of a separating funnel, and wash well. This oil contains both the ortho and para nitrophenol. It is placed in a large flask half full of water, and a current of steam passed through it. The orthonitrophenol is carried off by the steam, and can easily be condensed in the usual manner. When the steam ceases to carry off any more nitrophenol, the operation can be interrupted, and the tarry mass in the flask repeatedly boiled out with water, which extracts from it the paranitrophenol. By recrystallization from boiling water it is obtained in long white needles that melt at 110°, and forms a deep yellow salt with the alkalies. The ortho compound melts at 45°, is very slightly soluble in water, and yields a red salt with alkalies. Either of these may be employed as an indicator, but the ortho compound is preferable. The solution is of a deep yellow color when alkaline, but loses its color when acid. It may be used for acetic acid and for carbonates.

PICRAMIC ACID.

This acid was proposed as an indicator by Trébault, but our own experience with it has not been entirely satisfactory. It is easily prepared by dissolving picric acid in alcohol, adding an excess of ammonia, and then saturating the solution with hydrosulphuric acid gas. It is red in alkaline, yellow in acid, solutions.

PHENOLPHTHALEINE.

This substance was discovered in 1871 by Professor Baeyer, who obtained it from the action of sulphuric acid upon a mixture of phenol and phthalic anhydride. In 1877 E. Luck suggested its use as an indicator, and since it has become a commercial article (at $2 50 per ounce) it seems to have met with much favor among chemists. One part of the phenolphthaleine is dissolved in thirty parts of alcohol, and one or two drops of this solution are added to the substance to be tested. In neutral and acid solutions it is colorless, but a trace of alkali changes it to a beautiful rose color. The change is sudden and very easily seen, but we fail to discover its great superiority to coralline. It does not work well with the carbonates, and this is attributed by Vieihaber to the formation of a bicarbonate which does not affect this indicator. Results obtained with potassium carbonate, as will be seen below, differ about fifty per cent. from those got with other indicators. With acetic acid this indicator agrees very closely with coralline.

SALICYLIC ACID.

It is well known that the beautiful violet color produced by the action of salicylic acid upon salts of iron is destroyed by acids, and changed to a yellow by alkalies. Weiske proposes to make use of this property in alkalimetry, but we believe it is useless as an indicator.

Fluorescene and many other substances have been recommended, but as we set out to give merely the result of our own observation we pass them by.

For the purpose of comparing the various indicators we made up a dilute solution of caustic potash of unknown strength, and then proceeded to titrate it with a one-tenth normal sulphuric acid solution, taking 5 c.c. of the former for every experiment. The quantity of acid required is given below; each test being repeated three times.

	I.	II.	III.
Litmus	16·50 c.c.	16·55 c.c.	16·60 c.c.
Cochineal	17·25	17·25	17·15
Coralline	16·60	16·65	16·60
O=nitrophenol	16·65	16·55	16·50
Picramic acid	16·70	16·30	16·30
Phenolphthaleine	16·40	16·45	16·40

Tests were also made with 5 c.c. of a potassium carbonate solution. The quantity of acid consumed was as follows:

	I.	II.
Litmus	4·5 c.c.	4·4 c.c.
Cochineal	4·7	4·8
O=nitrophenol	4·4	4·2
Phenolphthaleine	2·4	2·5

Ordinary acetic acid diluted with water was then titrated with one-tenth normal alkali; 5 c.c. of the former required as follows of alkali:

	I.	II.	III.
Litmus	19·70 c.c.	19.75 c.c.	19·70 c.c.
Coralline	20·15	20·20	20·10
O=Nitro-phenol	20·00	19·90	20·10
Phenolphthaleine	20·30	20·40	

It will be seen that coralline and phenolphthaleine are best adapted to testing the strength of acetic acid, but nitrophenol can be used if care is taken to continue the addition of the alkali until a *deep* yellow color is reached. For general use, cochineal and coralline are quite sufficient.

It has been claimed by Siegwart that caustic alkalies could be determined in the presence of their carbonates by the use of turmeric paper, but this is apparently a mistake, as the difference in the color produced by each, when dilute, is very slight.—*Boston Journal of Chemistry.*

ON THE MICROSCOPICAL EXAMINATION OF FLOUR.—A METHOD BY WHICH THE FIBERS CAN READILY BE ISOLATED.

By CHR. STEENBUCH.

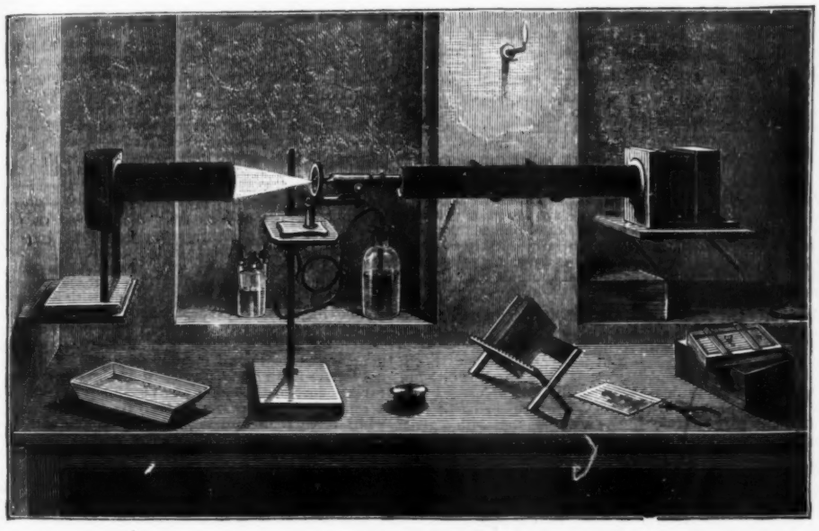
IT is a well-known fact that in examining flour for different admixtures of other varieties of flour, chemical analysis is inadequate, and that recourse must be made to the microscopical investigation. Such an examination must include partly the starch grains, their form and size, their behavior toward polarized light, etc., and partly the different fibers (the different layers of the epidermis, the gluten cells, and plant hair, together with the large, thin-walled, starch-bearing cells of the vegetable albumen) contained in the flour. Although in many cases the microscopic examination of the starch grains will be sufficient to show the origin of a flour, still the operation becomes much more difficult when it is necessary to examine a mixture of the different varieties of flour, in which the grains of starch differ only in size but not in form. Nevertheless, most text-books, as, for instance, König in his *Die Menschliches Nahrungs und Genussmittel*, states that the examination of the starch is the chief means of distinction. In Elsner's *Die Praxis des Nahrungsmittelchemikers*, the following is given: "The most important means of distinguishing the different varieties of flour are offered by the starch;" for while fragments of cells are found in the coarser and middling fine varieties of flour, they are rarely present in sufficient quantity and combination that by them alone a flour can be recognized. Any one who has been obliged to practically exhibit, for instance, that a rye flour contained an admixture of wheat flour, will appreciate the difficulty, even though accurate measurements of the starch grains have been made, of deciding the same, and the assistance given by the examination of the remaining fibers will be thoroughly recognized. This has already been indicated by Wiesner, when he says, in *Die Rohstoffe des Pflanzenreichs* (p. 288), with reference to the examination of a mixture of barley and wheat flour: "Only the most thorough measurements of the starch grains, and a very intimate study of the morphological relations of the structure of the grain of wheat and barley, can make the solution of the question possible."

At present the general rule is, that the finer a flour is, the less cellular material it will contain, for it is most all removed in bolting. Therefore, in the microscopical preparation of a sample of flour only a minute trace of any such ingredient will be found, and it is only after repeated elutriations that even with difficulty a satisfactory result will be reached. The problem is, therefore, how to remove the starch grains in such a manner that the remaining constituents of the flour will be unaltered. After numerous trials the following method has been devised, which permits of the preparation of such samples which consist essentially of the organic structure of the flour. It is based on the well-known fact that a solution of diastase will convert starch after a short while into dextrine and maltose. After inversion the solution is poured off, and from the sediment, which contains considerable quantities of albumen, which latter may be removed with dilute sodium hydrate, the entire structural elements will be found in an almost pure state. The method of procedure is as follows: For the preparation of the diastase solution twenty grms. of finely ground malt are placed in 200 grms. of cold water,

with repeated shaking during one hour, the solution is then passed through a double filter. Ten grms. of the sample of flour are made into a homogeneous pap, with 30 to 40 grms. of distilled water; the mixture is then introduced into a beaker, and about 150 grms. boiling water are added, with continuous stirring by means of a thermometer. The formation of a paste ensues, with a rise of temperature to about 75° or 80°. It is allowed to cool to about 55° or 60°, and 3 grms. of the clear filtered malt extract are added. It is then stirred, and the beaker placed over a water bath at a temperature of 55° to 60° for ten minutes. The mixture is then poured into a large quantity of water, decanted several times, and finally as much of the liquid is removed as is possible, and a one per cent. solution of sodium hydrate is poured on the sediment. The mixture is then shaken or digested for some time at a temperature of 40° to 50°, by means of which the amorphous albuminous substances are dissolved with the formation of a yellow solution; this is again poured into a large quantity of water, and the separated sediment will contain, with the exception of the starch, all of the organized constituents in an unchanged state. With reference to the treatment of sodium hydrate, it must be noticed that the reagent must not be too concentrated nor its action continued for too long, for otherwise the gluten cells would swell. According to some experiments, the above described method might be used for the examination of other substances containing starch flour where it is necessary to determine the other organized elements. Thus, for instance, beautiful preparations were obtained from cinnamon and cacoa, after the fats had been removed by ether.—*Berichte der Deutschen Chemischen Gesellschaft*, xiv., 2449.

MICROSCOPIC PHOTOGRAPHY APPLIED TO CHEMISTRY.*

ALTHOUGH the microscope renders the greatest services to the natural sciences, the use of the instrument proves of no less value in the physical sciences, especially that of chemistry. The microscopic examination of certain substances permits in a manner of making an analysis of them with a rapidity and certainty that would not be afforded by methods based upon the use of reagents, especially as regards organic matters. If, for example, the chemist has to satisfy himself of the purity of a specimen of commercial



MICRO-PHOTOGRAPHIC APPARATUS AT THE MUNICIPAL LABORATORY OF CHEMISTRY, PARIS.

starch, he throws a small pinch of the substance that he desires to examine into a little distilled water, stirs it with a glass rod, and then transfers, on the point of the latter, a drop of the solution to a glass slide, which he submits to a microscopic examination. He can thus obtain a general view of the starch grains, which all have a characteristic ovoid form. If the adulterator has mixed with the substance a certain amount of powdered gypsum, for instance, the latter will betray its presence at once under the form of angular grains having a crystalline aspect.

Coffee, chocolate, milk, pepper, etc., thus examined under the microscope, are immediately analyzed by an observer accustomed to study in this manner the different kinds of these substances, as well as the products which are most commonly used for adulterating them. It is the microscope that permits of detecting trichinæ in pork, and it is this instrument also that frequently serves for determining the nature of a salt that is observed to crystallize in a drop of water placed on a slide under the objective.

A microscopic inspection made directly as we have just indicated, however, presents the inconvenience that it leaves no durable trace of the observations. The importance of a photograph of the enlarged image of an object submitted to examination will be therefore at once understood. If a chemist has observed trichinæ in pork meat, he will thus not only be able to assert that the observation was made by the microscope, but it will be possible for him to show photographic proofs of the negative that he has obtained directly; and thus, by fixing them permanently, to multiply the material proofs of his analysis.

We recently visited the Municipal Laboratory of Chemistry, where, thanks to the politeness of Mr. Charles Girard, the director, and of Mr. Pabst, we had occasion to see in operation several micro-photographic apparatus, which are, we believe, the completest of the kind known in the way of this sort of arrangement. The system is a new one, and may be employed for microscopic studies of all kinds; so it seems to us that it will prove of interest to make it known.

The simplest system of micro-photography consists in applying a small dark chamber directly to the eye-piece of a microscope standing vertically as during direct observation, the illumination being obtained by means of a ray of light, from an oxyhydrogen or an electric light, projected on the mirror.

* From *La Nature*.

The virtual image is first transformed into a real image by displacing the eye-piece. In the microscope, the image furnished by the objective forms in the interior of the eye-piece, in front of the lens, between it and its focus. If the eye piece be drawn out so that the image formed by the objective is between the focus of the ocular lens and its center of curvature, the image then forms on the other side of the lens and becomes real, and it may be received on a piece of ground glass. The dark chamber is then adjusted and the focusing properly done.

Another method, due to Mr. Vogel, of Berlin, consists in seeking the virtual image situated in the microscope by means of a dark chamber and an objective of short focus. We know that the image forms virtually in front of the eye-piece, at about 0·12 m. or 0·18 m. according to the magnification of the ocular lens. The photographic objective is almost in contact with the eye-piece of the microscope.

These two methods are applicable to any ordinary microscope, placed in any room whatever—work-room or laboratory.

The third system which we are about to describe, and which is represented in the annexed figure, necessitates a special organization in a dark chamber made for its operation. It permits of taking the photograph of an object in several planes, and is especially applicable for obtaining photographs of histological sections, trichinæ, crystals, etc.

The microscope, which is placed horizontally, is represented in the center of the engraving. To the right is the photographic dark chamber, whose objective is connected with that of the microscope by a long tube. To the left is affixed to a shelf the oxyhydrogen or the electric light. The oxyhydrogen light will answer for obtaining negatives with magnifications of 300 diameters; but, beyond this, up to 800 diameters, the electric light is employed.

The apparatus under consideration is based on the principle that the pencils of light, with a great distance of conjugate focus, become almost parallel, and that the points situated in the planes contiguous to the focal plane are reproduced by points scarcely larger than those of the focal plane. The apparatus is installed in a dark room which is provided with all the accessories necessary for photographic operations, such as tanks, water-faucets for washing, etc.; and the operators who make use of it obtain excellent results by the new gelatino-bromide of silver processes.

In the Laboratory of Chemistry we have looked over a remarkable photograph album, in which were to be seen very good proofs of micro-photographs of chocolate, coffee, pepper, milk, trichinæ, etc., for the analysis of which it is of interest to employ the microscope. It would be interesting to publish such photographs, so that they might serve as types for the very numerous amateurs who, owning a microscope, would like to ascertain the purity of the food products that they are using. They would thus have before their eyes the exact *portrait* of the different substances free from any adulteration, and would be in a position to assure themselves (by means of easily made comparison) of the quality of the food products consumed in their house.

THE SOFTENING OF HARDENED RUBBER STOPPERS.

SCHNEIDER recommends for this purpose that the hardened stoppers be digested for about ten days in a five per cent. solution of sodium hydrate at a temperature of 40° to 50° C. Then they are washed and the outer portion is scraped with a dull knife until it is no longer possible to remove anything. They are again washed in warm water, after which they will be found ready for use.

DETERMINATION OF TANNIC ACID.

By M. LEHMANN.

The author takes a quantity of the sample supposed to contain from two to six decigrammes of tannic acid. It is exhausted with boiling water, and the liquid is concentrated down to 100 or 200 c.c. of filtrate. To 20 c.c. of this solution are added 20 c.c. of a saturated solution of ammonium chloride. There is then run into the mixture by means of a burette graduated in tenths of c.c. a solution containing 1 grm. gelatin in 100 c.c. of a saturated solution of ammonium chloride. The presence of this salt renders the separation of the precipitate both rapid and very distinct. The flow of the solution of gelatin is stopped as soon as a precipitate no longer forms. To find the exact moment when the tannin is entirely precipitated, a small quantity of the liquid is filtered, and the filtrate is tested upon a watch glass with solution of gelatin and with the solution of the sample. It should give no precipitate with ether. The gelatin solution is standardized previously with a solution of pure tannin.

[Continued from SUPPLEMENT 308, page 4913.]

SOAP AND ITS MANUFACTURE FROM A CONSUMER'S POINT OF VIEW.

IN our last article on this subject, we pointed out the enormous extent to which the adulteration of the various classes of soap now sold to the public had been carried; also the injurious effect of these adulterations—often causing the destruction of the articles with which they were washed—and the injury caused to the hands and skin by the use of these adulterated soaps. These deleterious effects to health, by the use of the putrid and diseased fats and greases, often employed by the soap boiler in the manufacture of his soap, were touched upon, and the opinions of some eminent surgeons as to their possible action in germinating skin diseases and blood poisoning were mentioned. The advantages and general superiority of articles made for use and not for sale were pointed out, together with the recommendation that soap should be more extensively made by the *consumer* for his own consumption. The great improvement in late years in the production of soap making alkalies, that is to say, pure caustic potash and powdered 98 per cent. caustic soda was shown; and also how that with these articles pure soap could be made without any boiling and by a simple mixing process.

We now propose to continue this subject by pointing out the best means of making soap by this method. Before doing this, however, we would say that this mixing process, or "cold process," as it is sometimes termed, is not new. It was proposed some years ago, and actually a very imperfect recipe will be found in the directions given for the manufacture of soap on the so-called "concentrated lye," now sold to the public, as well as in many books on the subject of soap making. In actual practice, however, either on a large or small scale, these directions would not work, and simply for this reason: To make a perfect soap by the cold or mixing process, it is absolutely necessary to have a pure caustic soda; without this, perfect saponification never can or will be effected without boiling, and an imperfectly made cold process soap is very objectionable. Hence the value of pure caustic soda.

Now, in passing it may not be unadvisable to consider the various qualities of caustic soda that are sold to the public for soap making. The original quality of caustic soda, first introduced and put upon the market some 30 years ago, was about sixty per cent. strength. As time advanced various intermediate strengths were introduced, up to seventy per cent. of soda. Both these strengths also have been put up and sold to the public as lye for family soap making. Most generally, however, the tendency has been to follow the course adopted by the soap makers—that is to say, to adulterate with salt, lime, and all kinds of substances, and give a *cheap lye*. We regret to say that this system of adulteration has been carried to great perfection, most of the so-called "lye," or "ball potash," consisting almost enterely of impurities, and consequently actually utterly unfit to make soap by the boiling process, or even efficiently soften water! This adulteration of lye and ball potash, from a social economical point of view, is much to be regretted, as it has discredited even the old boiling soap making process by small consumers, and prevented the utilization of much waste grease, which has been thrown away instead of being converted into soap, which otherwise would have been the case.

Within the last two years, however, a great advance has been made in the improvement of the quality of caustic soda. A powdered 98 per cent. article, that is to say, a caustic soda within two per cent. of theoretic purity, and in the convenient *powd red* form, has been introduced. There is a twofold advantage in the manufacture of soap with this article; not only can soap be readily made by it, in either large or small quantities, by the cold process, but owing to its being in a powdered form, the necessity of having small packages, as in the case of the old-fashioned solid lye, containing just sufficient for one boiling, is entirely avoided, even in the case of the smallest consumer. A ten pound package of powdered 98 per cent. caustic soda is even more convenient than a one pound package of solid caustic soda, as, being in a *powder*, the exact quantity required either for making soap, softening water, or any other purpose, can be taken out without breaking up or destroying the package, as in the case of solid caustic soda. As far as soap making also, is concerned, so small a package as one pound, even for household consumption, is quite unnecessary. With the old boiling soap making process, one pound of caustic soda was all that could be conveniently manipulated at a time—the limit being simply the boiling kettle generally at hand in an ordinary household; with soap making by cold process, as far as household production is concerned, the limit is simply the amount of grease that can be conveniently accumulated. Instead, therefore, of constantly making soap by the tedious boiling process in little batches, the grease can be kept, and in place of making ten or twelve pounds of soap at a time, as in the case of the ordinary lye, one hundred and twenty pounds can be more easily, and with less trouble, made at one operation, with the contents of a ten pound can of pure powdered caustic soda. This fact seems at any rate to be recognized by one firm of alkali manufacturers—the Greenbank Alkali Co., of St. Helens, England, who put up their powdered 98 per cent. caustic soda in barrels for large consumers, down to a ten pound canister for soap making on a small scale, and other general uses.

To come, however, to the best means of producing hard soap, either for family use, laundry purposes, or for general consumption, the following simple directions are all that is necessary for this purpose:

Take ten pounds of powdered 98 per cent. caustic soda and put it in four gallons of soft water. It will dissolve immediately and become hot. Let the liquid lye thus obtained stand and cool a little till it feels just warm to the hand, say 80° F. Melt seventy pounds of grease or tallow till liquid and warm to the hand, say 120° F. Now pour the lye into the grease, stirring with a flat wooden stirrer for a few minutes until the two are combined and smooth in appearance. Pour into a square box for a mould, lined with muslin or calico to prevent the soap sticking to the sides. Wrap well up with woolen coverings, and put in a warm place in order to keep in the heat generated inside by the mass slowly turning into soap. After two or three days the soap will be formed. It should then be taken out of the mould, cut up into bars, and kept in a warm room for about a month, the quantity being about one hundred and twenty pounds.

All soap is much improved by keeping, more especially when made by the cold process, as it lathers so much better. Yet at the same time, what is a very important point when the soap is made for sale, the glycerine it naturally contains does not allow it to shrink or lose weight, as in the case of a boiled soap, in which this article is absent, having all been

lost in the spent lyes. The importance of glycerine in soap is very great. This substance is naturally contained in tallow or oil to the extent of about eight per cent.; its emollient and lubricating properties are very great, and yet it is sacrificed and lost in the case of a boiled soap, by the salting process necessarily employed when rosin and impure soda ash are employed to cheapen the cost of production.

The above directions are intended for the production of a laundry or houshold soap for general purposes. For a toilet soap, rather more tallow is necessary to render the soap quite neutral. In this case seventy-five pounds of tallow should be taken instead of seventy pounds. The substitution, also, of twenty per cent. of cocoa nut or cotton seed oil, for an equal quantity of tallow, will improve the soap and cause it to lather more freely. The perfuming can be accomplished by the addition of two ounces of wild thyme, citronella, almond oil, or other essential oil, stirred in just when the mixing is nearly completed. In this way a first-class toilet soap can be easily and readily produced.

For washing flannels and woolens, soda soap should not be used, as *real* potash soap, which lathers and washes equally well in cold water as in hot water, is much to be preferred. Potash also is intended by nature for washing woolen goods, as when it is used they neither shrink nor become harsh. This subject, however, must be reserved for a future occasion.

NOTES ON ECONOMIC PLANTS.

REFERRED TO IN THE KEW REPORT FOR 1880.

IN the Kew Report for 1880, which was issued in December last, many facts occur in connection with the diffusion of useful or economic plants into the various British colonies, and also on the subject of clearing up the nomenclature of plants whose botanical origin has hitherto been either unknown or doubtful. Much space is given, as might be expected, to reports from different parts of the world on the cultivation of new and valuble species of *Cinchona*. Thus *Cinchona ledgeriana* is referred to as follows: The extraordinary richness in alkaloids which has been evinced by selected strains of this cinchona, under the skillful management of the Dutch government plantations in Java, has naturally attracted the attention of planters of the importance of cultivating it, as other kinds of cinchona would necessarily stand a poor chance with it in commercial competition. A very large number of applications has been addressed to Kew for a supply of seed. This has been partially responded to, partly through the courtesy of the Dutch government, and partly by a supply from the Indian government plantations of Sikkim. A correspondent in Ceylon writes: "The *Ledgeriana* plants here on our estate 'Conon' are doing uncommonly well, and as far as I can judge, they seem to be growing faster than *officinalis*, and I am not sure that they do not grow faster, and girth as fast as *succirubra*. . . . From what I hear, our clearing of twenty-five acres with about 25,000 plants is the largest in the island, and of the best sort." These 25,000 plants were all raised from two ounces of seed. It will be seen from this estimate that an acre of land will grow a thousand plants. This species has also been introduced to Jamaica, from whence the plants were reported as being in a fine healthy condition. The prospect of establishing this species in Jamaica is considered of the highest importance, inasmuch as the bark grown in Java has realized 17s. per lb.

In the Nilgiris this species seems to grow very satisfactorily, provided the plants are first raised under glass with heat; for it is stated "experiments go to prove that the hills are too cold for the *Calisaya*. It is certainly too cold to raise them from seed in the open air." The writer of the foregoing paragraph further says: "In Wynaad, men are clamoring for *Calisaya ledgeriana*, if possible, but anyway, *Calisaya*. There are so many applicants, that I have little hope of getting *Ledgeriana* seed from Mr. Moens. I saw Mr. Cross here soon after he had brought out the *Calisaya de Sante Fé*. The plants looked strong and healthy. I believe, from what Mr. Cross said, the kind will do here, but not in Ootacamund. He said the *habitat* is the canons high up the Andes, where, though near the snow line, there is always a hot wind from the plains. Ootacamund is the center of the hills. Round the Ghauts might be found suitable spots for it. I have here, at Greenway, 80,000 odd trees of *Condaminea*, in various stages of growth. I went to the government gardens, and saw the eight or ten-year old *Ledgeriana* trees—some dead, others dying. Up here they will not renew their bark, and consequently die. The *Calisaya* ordinary variety, too, in the gardens, does not throw up a straight stem, but forms a bush rather than a tree. The *Ledgeriana* forms a tree, certainly, and thrives till barked. My *Condamineas* are growing well. Many are ten feet high now—planted in 1877; in four years time they ought to be ready for barking."

COCOA PLANTS FOR EASTERN COLONIES.

Mr. Horne, the director of the Mauritius Botanic Garden, having visited Fiji, at the instance of the governor, Sir A. H. Gordon, reported to the Colonial Office that it was peculiarly desirable to introduce into the islands, as well as the eastern colonies, "the twelve or thirteen superior varieties of the cocoa plant in cultivation in Trinidad." Arrangements were accordingly made, and in the course of last autumn, seven Wardian cases of cocoa plants were received from Trinidad at Kew, in excellent order; and after examination and re-packing, transmitted to Ceylon, whence it was arranged that portions of the collection should be sent on to Singapore and Fiji respectively. The transmission to Ceylon was fairly successful, and Dr. Trimen has since made the distribution. Individual planters in the East have already largely supplied themselves with cocoa-seed from Trinidad. It was thought that it would be advantageous, however, to have in the botanic gardens of the colonies above mentioned, standard collections of varieties for future observation and experiment. In an official report on the subject, Mr. Prestoe, the government botanist at Trinidad, marks: "The best kinds are by no means well-known. Indeed, with the majority of growers here they are not known at all, and they never notice a difference in the character of the trees nor that of the sample of produce, except in respect of the *Calabacillo*, or 'wild' cocoa, and this they very rarely eliminate. In the whole range of varieties, however, there is a difference in the value-yield of at least one to five. Under these circumstances, the value of the cocoa plants now forwarded should be regarded as of rather a botanical or scientific nature than as an agricultural or economic one, for immediate effect for the varieties being separated and described, as far as it is practical, to have them, there is a base for experiments, and tests as to what are their real characters, and what may be done with them in the way of improvement."

COLA NUTS.

Some very interesting particulars are given on the West African trade in cola nuts, the seeds of *Cola acuminata*. We are informed that the import of these seeds amounted in 1879 to 108,000 lb. more than in 1878. On the other hand, the export was 58,000 lb. in excess of the export in 1878. The trade in cola nuts is an attractive feature in the commerce of the Gambia. The cola nut is the product of the Sierra Leone district, and the trade in it, both at Sierra Leone and the Gambia, is almost entirely in the hands of women, to a large number of whom it affords the means of livelihood, and in many instances the acquisition of considerable wealth. The nut is largely consumed by the natives of the Gambia; it is of a bitter taste, and produces no exhilarating effect, but is said to possess the power of satisfying for a considerable time the cravings of hunger. For this purpose, however, it is much less used than it is as a luxury. The trade in the article is rapidly increasing.

	Pounds.
In the year 1860 the import was about	150,000
" 1870 " "	416,000
" 1879 " "	743,000

The trade in cola nuts has also spread to Central Africa, and even to the African shores of the Mediterranean.

The plant has been introduced from Kew to the West Indies, Seychelles, Calcutta, Ceylon, Dominica, Demerara, Mauritius, Sydney, and Zanzibar.

FODDER PLANTS.

Tagasaste (*Cytisus proliferus*), *Adelaide*.—Dr. Schomburgh reports: "The seeds have grown uncommonly well, the plant reaching a height of four to five feet. There is not the slightest doubt that this plant delights, not alone in our climate, but in any kind of soil and situation. . . . I do not doubt a moment that this shrub, if sown on the sheep-runs, naturally well covered with soil, will soon become acclimatized, and will stock the runs with a new fodder-plant."

Brisbane.—In these gardens the seed germinates freely in the open air, but makes but little progress in its subsequent growth.

Teosinte (*Euchlæna luxurians*), *Adelaide*.—Dr. Schomburgh reports: "I have now cultivated it for the last three years, and no doubt it is one of the most prolific fodder plants. Notwithstanding the prevailing dryness of the two last summers, the hot winds did not injure it, the plants not showing the slightest effect on their leaves, which preserved their healthy green, while the blades of the other grasses suffered materially. The habit of throwing out young shoots is remarkable, to the number, in some plants, especially such as stand in a moist situation, of fifty to sixty, with a height of five to six feet. There is one drawback. The plant, as I have already remarked, being essentially tropical in its habits, the ripening of the seed-crop will be problematical with us, as early frosts will kill the plant."

Jamaica.—Mr. Morris reports: "Treated as a garden plant, the *Euchlæna* has grown well at Castleton gardens, but sufficient experience has not yet been obtained to express an opinion whether it will prove generally suitable as a fodder-plant. A good crop of seed has been harvested and widely distributed for experimental purposes in different parts of the island."

Madras.—The Agri-Horticultural Society report: "*Euchlæna* (*Reana*) *luxurians* continues to grow luxuriantly, seed, and reproduce itself, with so little care and watering as to confirm the opinion expressed in last annual report, that it may be considered a success. It is particularly worthy of growth in private gardens, a few stalks of it giving a green bite to horses in the long dry weather, when change of food is so hard to get. . . . As a single crop, with a given quantity of water and moderately good soil, the *Reana* will produce, in hot weather, a much greater bulk of green fodder than either lucerne or guinea-grass, which are most commonly grown in Madras for the purpose."

INDIA-RUBBERS.

Under this head a great deal of space is devoted to the several plants which yield the different rubbers of commerce. On the subject of the Central American rubber plant, *Castilloa*, in Ceylon, Dr. Trimen is quoted as follows: "Two plants have been sent to Calcutta. Those in Burmah are reported to be flourishing. Much better success now attends the propagation, by cuttings, of this fine species. Our largest trees at Heneratgoda have now a circumference of nearly seventeen inches or a yard from the ground, and the trees are beginning to take their true form."

Ceara Rubber (*Manihot glaziovii*), Ceylon.—Dr. Trimen says this is still the only species which has flowered. "Seed has been supplied, during the year, to the Government gardens in India (Calcutta, Saharunpore, Ootacamund), and distributed as widely as possible among the planters in the colony, 24,550 seeds having been thus disposed of, as well as 1,879 rooted cuttings. We have also sent small quantities to the Botanic Gardens of Singapore, Mauritius, Jamaica, British Guiana, and Kew, the Acclimatization Society of Queensland, and Mr. Low, Her Britannic Majesty's Resident in Perak."

Dr. Trimen adds, "this plant is now flourishing in Ceylon in suitable places, and proves very hardy; in the new estates in the Trincomalee district, it is reported to be thriving, but to have shown itself intolerant of wet. In the Nilgiris, I am informed, it is doing well at 2,400 feet; and Major Seaton reports from British Burmah that there are 500 and upward set out and well established in the Mergui plantation."

Jamaica.—Mr. Morris reports: "This plant is evidently of a very hardy character, and adapts itself readily to the exigencies of culture. Plants at Castleton (600 feet) and at the Parade Garden, Kingston (50 feet), are doing well. At the former gardens, young trees, when about 9 to 12 feet high, were beginning to flower, but the hurricane deprived us of the hope of procuring seed this year. Judging by reports from South America, it is possible that tracts of dry, stony—almost worthless—lands, in the plains, may be turned to good account by means of this cultivation."

Para Rubber (*Hevea brasiliensis*).—On the cultivation of this rubber plant in Ceylon, Dr. Trimen reports that it "will be probably found to be satisfactory only in rich land, not much above sea-level, where the temperature is high and equable, and the rainfall large. At Peradeniya, the trees are making but slight progress, and suffer from wind, especially in the dry north-east monsoon. At Heneratgoda, their progress is all that could be wished. Our largest trees are now, at three feet from the ground, sixteen inches in circumference. During the year, 602 cuttings were raised and distributed. *Hevea* has proved completely unsuited to the climate of Calcutta, but is doing well in Burmah and Perak. In the latter place, a tree has flowered sparingly, at two and a half years old, and 35 feet high."

African Rubbers (*Landolphia spp.*).—On this point it is stated that all the present commercial sources of African caoutchouc belong to the above genus, which is a group of woody climbers, all of which probably yield caoutchouc peculiar to tropical Africa and the adjacent islands. African caoutchouc comes into commerce, both from the west and the east coasts, and only one of the rubber vines is common to both. Three species of *Landolphia* are described as producing caoutchouc on the West Coast of Africa. The form in which West African rubber comes into commerce is somewhat peculiar; it is accounted for by the method of collection, which has been described as follows: Every part exudes a milky juice when cut or wounded, but this will not run into a vessel placed to catch it, as it dries so quickly, and forms a ridge on the wound, and stops its flow. The blacks collect it by making long cuts in the bark with a knife, and as the milky juice gushes out, it is wiped off continually by the fingers, and smeared on their arms, shoulders, and breasts, till a thick covering is formed. This is peeled off their bodies and cut into small squares, which are then said to be boiled in water. The three species referred to above are *Landolphia owariensis*, *L. mannii*, and *L. florida*. From the East Coast of Africa four species are referred to as furnishing rubber of commerce, namely *L. florida* (before referred to on the west), *L. kirkii*, *L. petersiana*, new and undescribed species, and a species, though distinct, not yet sufficiently known to admit of scientific description. The following extract from a report to the Foreign Office by Mr. Holmwood, the Vice-Consul at Zanzibar, is descriptive of the mode of collecting the rubber: "The process consisted in cutting clean slices of bark from the trunk and branches, from 3 to 10 inches in length, and from ½ to ¾ inch in breadth. The cuttings were made sometimes from one side only, but generally they were scored all over the tree, about half of its bark being thus removed. The method of making the balls of rubber—which average two inches in diameter—is as follows: A quantity of milk is dabbed upon the forearm, and being peeled off, forms a nucleus. This is applied to one after another of the fresh cuts, and being turned with a rotary motion, the exuding milk is wound off like silk from a cocoon. The affinity of this liquid for the coagulated rubber is so great, that not only is every particle cleanly removed from the cuttings, but also a large quantity of semi-coagulated milk is drawn away from beneath the uncut bark, and during the process, a break in the thread rarely occurs. By working hard, one person can collect 5 lb. of rubber per diem, though the average is one half this amount. I was assured, however, that in the interior, where the trees were large, it is no uncommon thing for one man to collect 7, or even 9 lb. in a day. The regular season for the collection of India-rubber lasts from about the middle of May till the first week in December. This has little connection, however, with the state of the tree, but is owing to the natives being generally engaged during, and for some time after, the rainy season in cultivating their lands."

He further reports, that, in the districts of Mungao and Kilwa alone, India-rubber "has created a new trade, which finds profitable employment for all those classes whose means of subsistence came to an end with the suppression of the illegal slave trade. The total exports from these places now (1880) exceeds 1,000 tons annually. Since last season the price has risen from £140 to £150 per ton, and there seems no reason to suppose it will ever again fall to the former figure." With regard to the destruction of the rubber vines by the collectors, Vice-Consul Holmwood takes a somewhat gloomy view. He says it is "admitted that, while three years ago the supply of India-rubber was altogether derived from the country within 50 miles of the coast, the great bulk was now procured from Mahenge and Ubena, countries distant 150 to 200 miles from Kilwa; the supply from the more adjacent districts having, moreover, greatly fallen off, and, in some instances, entirely ceased."

Consul O'Neill more recently remarks, in his report for 1880, on the trade of Mozambique: "It is curious to note the marvelously rapid development of the India-rubber industry. In 1873, only £443 worth of India-rubber passed through the custom-house of Mozambique; in 1876, it reached the value of £23,198; and in 1879, it exceeded £50,000. It would seem, now, to have reached its climax, while the present rude method of collecting this produce prevails, and until communications with the interior are properly opened up, for the careless cutting of the trees by the untaught hands of the natives has resulted in the destruction of enormous tracts of India-rubber forests near the coast."

From specimens of rubber-yielding plants received at Kew from Sir John Kirk, it seems that one of the Zanzibar plants is a species of *Landolphia* hitherto unknown to science, and now proposed to be called *Landolphia kirkii*, in honor of Sir John Kirk. With regard to the mode of collecting the rubber from *Landolphia petersiana*, Sir John Kirk thus describes it in a report to the Foreign Office: "The mode of preparation of this India-rubber differs essentially from either of the other two kinds, the juice being here gathered in a fluid state, by tapping, and coagulated by heat, or in some other way, similar to that used in Madagascar or the Brazils. The product, however, is said to be of an inferior quality."

On the subject of Bornean caoutchouc, the Kew Report says: "The most authentic information on the caoutchouc-yielding species of North West Borneo is apparently that contributed by Mr. Treacher to the 'Journal of the Straits Branch of the Royal Asiatic Society,' for July, 1879 (p. 58). He enumerates no less than eight, with the following names:

1. Manungan pulau (*i. e.*, Manungan proper).
3. Manungan bujok.
3. Manungan manga (light colored bark).
4. Manungan manga (dark colored bark).

"From the above is obtained the gutta lechak or gutta susu of commerce. (Gutta in Malayan means gum; *lechak*, elastic; *susu*, milk.)

5. Serapit larat.
6. Serapit pulau.

"The produce of these is only used to increase the weight of the manungans, the milk not hardening sufficiently of itself.

7. Bertabu or petabo pulau.
8. Bertabu or petabo laut.

"The produce of these is no longer marketable. The different plants would appear to be accurately distinguished by

the native collectors; and if the best of them are to be sought and brought into cultivation, their precise botanical identification becomes important.

"No. 1 of the foregoing list is referred to as a new species of *Willughbeia*, the name proposed for it being *Willughbeia burbidgei*.

"No. 2 is *Leucenotis eugenifolius*.

"Nos. 3 and 4 are supposed to be species of *Willughbeia*, and *W. treacheri* is proposed for No. 5.

"The remainder would at present seem to be undeterminable. All the above species belong to one natural order, namely, *Apocynaceæ*. Other caoutchouc-yielding plants are referred to in the report, which are, however, of minor importance as compared with those just enumerated.

"Regarding the collection in Perak of *Gutta singgarip*, the produce of *Willughbeia burbidgei*, the following description is given: 'The stem is generally ringed at intervals of 10 to 12 inches, and the milk allowed to run into vessels made of palm or other leaves, cocoa-nut shells, or anything available for the purpose; it continues to flow for some time, but after flowing for some minutes, it gets very watery and thin. One flow will yield from five to ten catties of the coagulated caoutchouc. When raw, it has the appearance of sour milk, and to coagulate it the natives add salt, or salt water. When freshly coagulated, it is quite white, which gradually changes to a darker color. It keeps white inside, and on cutting, it presents a foveated appearance, the cells containing water and salt, which have become inclosed during coagulation. In texture it is soft, very spongy, and very wet."

TEA CULTIVATION.

India.—The following statement, quoted from the *Madras Mail*, gives a striking picture of the progress made by this industry: "In 1850, the area under this plant was approximately estimated at not more than 1,000 acres, and the total out-turn of tea at little over 350,000 lb. At the present time, the area under plant may be put down at 206,700, viz.: Assam, 85,000 acres; Cachar, 47,000 acres; Sylhet, 18,000 acres; Darjiling and Terai, 34,000 acres; Dehra Doon, 4,300 acres; Kangra Valley, 7,400 acres; Kumaon, 4,400 acres; Chittagong, 4,200 acres; Chota Nagpore, 3,300 acres—producing about 40,000,000 lb. of prepared tea, and representing a capital invested not far short of fifteen millions sterling, while about two millions sterling are spent annually in India in the working and up keep of the plantations. Of the advantages accruing to India—directly to the people, and indirectly to the government—from the disbursement of so large an amount of money, there can be no question. It will be seen that, of the total area of 207,600 acres brought under cultivation, 150,000 acres lie within the administrative circle of the Chief Commissioner of Assam; and the statistics of that province demonstrate the continuous and rapid progress of its revenue and general prosperity during the period in question—a prosperity which may be fairly claimed as being almost entirely due to the beneficial influence of the tea industry. There still remains, however, a vast field for future development, not merely in the production of tea, but for almost every kind of crop grown in India, more especially rice.

United States.—The following experiment, in the direction of enabling the United States to grow its own tea supply, seems to be worth nothing. The Commissioner of Agriculture reports that Mr. John Jackson, who had had the management of tea plantations in Assam, had purchased the estate of Dr. Jones in Georgia, on which were growing patches of neglected tea plants of all sizes, most of them having sprung from a few old trees set out by Dr. Jones in 1850. Mr. Jackson laid out a tea garden of 100 acres, and made samples of tea from the leaves of the older plants. Those were sent to Messrs. W. T. & H. Thomson, of 38 Mincing Lane, who reported: "The samples represent that of a high type. The flavor, though not strong, is remarkably fragrant. The infused tea indicates somewhat too light fermentation, but has all the characteristics of high quality. There can be no doubt, apparently, as to the feasibility of tea cultivation in the Southern States. The ultimate success of the experiment will probably depend upon the supply of labor at a sufficiently cheap rate, to enable the produce to compete with foreign tea."

Among the various things treated of in the Kew Report, besides those more important articles of commerce which have been referred to here at length, are paper materials from Indian fibers and wood pulp, turpentines from Indian coniferous trees; gambier, or terra japonica, from *Uncaria gambir;* coffee diseases in Ceylon, Fiji, and Venezuela; and many other points of interest both to planters in our colonies, and to the commercial man at home.

MULBERRY TREES FOR SILK.

By MRS. V. C. HAVEN.

IT is my object to give in these few pages suggestions to those who feel interested in silk culture, in the view of its becoming a national industry, which will aid them in choosing, *first*, the right kind of food for the silk worms, and how to cultivate the mulberry tree.

The food plant of the silk worm is the mulberry, of which two species are the best for this country—the white mulberry (*Morus alba*) and the Japan (*Morus japonica*). The *Morus multicaulis* is not hardy in this climate.

The mulberry grows readily and is easily propagated by cuttings, the easiest and surest method of planting to secure a stock. The cuttings should be planted in rows, four to six inches apart, in light, rich soil, prepared by deep plowing and well pulverized. They should be about six inches long, and each to have not less than two eyes; three are more certain of growth. They should be almost entirely buried, leaving one bud above ground. The rows should be about three feet apart, which will give sufficient room to pass between them.

The quickest way to get a supply of leaves is to grow dwarfs. Set out the young trees from the nursery in rows twelve to fifteen feet apart, and let the trees be from six to eight feet apart. Cut the tree down to about fifteen to eighteen inches from the ground. The height of the tree is easily regulated. The process of pruning promotes a strong and vigorous growth, and keeps the foliage within reach of easy picking for feeding purposes.

The best time for planting cuttings or trees is in either March or April. The cuttings should not be transplanted before the second year.

OSAGE ORANGE.

The cultivation of this plant is so well known in this country that it would be useless to give any instructions about it. Those who use it as silk-worm food must bear in mind that the young shoots become very vigorous and succulent by the time the worms are in the last age. These milky and succulent leaves should be thrown aside, as they are apt to cause disease.

The planting of *mulberry trees* in the hedge form will be found very advantageous; the same quantity of land will thus produce more leaves than from the standard trees, and the labor of gathering full one-half less. In the country and villages where every family have plenty of ground by their dwellings, trees may be planted by the fences, so as to let the children pick the leaves to feed the worms. This is what may be termed cottage culture, and every family of four or five children, in six weeks can earn more than all the clothes they wear would cost.

As the best and first thing to be done by a silk grower is to cultivate the kinds of mulberry trees or plants which will give the largest yield of silk, I say nothing of feeding on the oak or ailantus leaf, as there is not enough of experience with either to afford a judgment on the result. We *know* that the *Morus alba*, or white mulberry, and the *Morus japonica*, or Japanese mulberry, are certain to produce the best silk, and experiment will only increase expenses and render the value of your crop uncertain.

The *Morus japonica* has the largest leaves, and is so easily picked that the French breeders prefer it to any other, as a cheap silk producer. Its standing well the winters of the North, is proved by five years' growth in Kansas. It grows easily by cuttings, and many stems grow six feet high the first year.

We are all aware that climate is a matter of first importance in the growth of the mulberry tree. The great metropolis of China, Peking, 39° 54' N latitude, about three miles south of Philadelphia, may be quoted as the northern extremity of her silk-growing country, which extends as far south as the twentieth parallel of north latitude. It is in her central provinces, between the twenty-fifth and thirty-fifth degrees of latitude, that the greater part of her silk is produced. The eastern shore of North America is, in this respect so similarly situated to the same shore of the Asiatic continent, that the mean annual temperature of any given degree of latitude on our Atlantic shores will be found very nearly to correspond with the same degree of latitude in China, near the Pacific. China also, in point of extent of surface and territory, very much resembling those of the United States, it is evident that we, of all nations under the sun, have the best chance to equal that eminent nation as to the "golden fleece." Nature has done all she can for us; will a sound policy effect the rest? The question was asked in regard to the special industry of silk raising in 1623, and is not yet answered. In 1783 the legislature of Connecticut granted a bounty on mulberry trees and raw silk. In 1810 the sewing and raw silk of New London, Windham, and Tolland were valued by the United States marshal at $28,503, exclusive of the amount of "domestic fabrics." In 1837 it was announced that the "mulberry will grow and the silk worm thrive throughout the whole length and breadth of the United States."

A few acres of land of ordinary fertility, and a few dollars in money for the purchase of seeds and plants, will enable a silk grower to buy the foundation of a plantation on a considerable scale, and the first thing to be done toward the production of silk is a provision of food for the worm, that will take due care to perform its part if only we are careful to perform ours.

The quality of the silk does not entirely depend upon the food; general care throughout the entire progress from the egg to the cocoon is very essential to secure good cocoons. The general experience teaches that the best condition of the leaves for feeding is that they are free from dew or rain. The stripping of the leaves should not be begun until the dew has been absorbed by the heat of the sun, and ought to be finished before sunset. Wet leaves produce diarrhea, and it is important to have a supply of dry leaves. To avoid accident, and to secure a supply for rainy days, a stock should be kept on hand; they will keep for a couple of days in a cool dry cellar; a brick or stone floor is best, or on a clean linen sheet in a cool dark room. Do not let them be too much heaped together, and do not allow a change of temperature in "leaf store," tending to promote fermentation if gathered in hot weather, or left too long in a state of compression in bags or baskets. Dusty leaves must be wiped with a soft linen cloth. Accurate thermometers are very needful in silk culture, and every room in which the work is carried on should have several.

It should be impressed upon children and all who are employed to pick leaves, to pass the hands up from the lower part to the top, to strip off the leaves upward, not downward, as the latter may injure the buds. The picking of the leaves requires great caution to prevent injury to the trees; nature never intended that they should be violently stripped of their foliage. All climbing of young trees should be avoided. Pruning shears are very needful for tall trees. A pair can be attached by one of the handles to a pole of any height most convenient, say ten feet, which, while it is held in one hand, is worked by the means of a cord passing through a pulley and attached to the other handle by the other hand. In the cities we see the tree trimmers using them in the streets every spring. My own preference would be for dwarf trees or hedges, if I were undertaking silk culture as a business, because silk worms, when preparing to spin, eat an immense quantity of food, and the easier the gathering of leaves is made, the better for all concerned in the feeding process.

As a rule, keep back the first hatching until the first leaves are developed sufficiently for food, but it is not always possible to do this in the variable climate of our northern springs. Last spring the association received from Georgia specimens of cocoons before the first leaf had appeared in the park, which shows that south of forty degrees should be the headquarters of silk culture, where the climate renders the work easier and certain of success.

To be provided with a resource against a backward spring, those who have space will find that a small hedge, the width of a garden border, will answer, if planted in a southern exposure, sheltered by a building. Early in the spring, cover the hedge with straw or matting to protect it from the frost at night. A small space is sufficient, as in their "first age" the worms require very little food. I have heard that by careful gathering of the leaves in the early autumn, before they begin to fall they can be dried and preserved, so that by carefully soaking them in pure cold water, and drying with a linen cloth, they can be fed to the early hatch quite acceptably.

At the rooms of the association some few eggs from the South, which had been laid on cocoons, have hatched, and are being fed on lettuce as an experiment; but as it is the sixteenth day of January, and "ne'er a leaf," we shall feel no surprise that they can't live.

Under the heading, "Mulberry Leaves and Statistics," in the last edition (1839), of the best book on the "Mulberry Tree and Silk Worm," by Mr. J. Clarke, I find that in silk culture abroad there is a "division of labor." The "renting of trees and selling of leaves" is a business for a farmer or owner of land; it is one branch of the work, that of "producing silk" is another, and the connecting link is a "leaf market."

A leaf market in a city renders it quite possible for otherwise unemployed women and children, whose houses have more rooms than are occupied, to raise silk. If the children only are employed, it would be a great benefit; but there are women, old and young, incapable of heavy work, in all our populous cities, whose success in silk raising would not only support themselves, but enrich the nation.

If productive labor is a source of wealth, both to nations and individuals, it is desirable that it should be increased to its greatest possible extent. This can only be done by seeking out objects to which the labor of the young, old, and infirm is adapted, and among these is none more appropriate than the culture of silk. The same remarks are substantially true with respect to its manufacture.

Leaf markets are established facts, not only on the continent of Europe, but in Asia. I quote from an eye witness:

"On all the roads and avenues to Broosa we saw mules, camels, asses, with all manner of conveyance, freighted with mulberry leaves for the leaf market. In the city itself we saw many families, on the approach of the silk-raising season, on the move to clear and make ready for the labors of the silk worm, every spare apartment in the house. *Two-thirds of every house is a cocoonery.*"

In the town there is the leaf market every day, and in the houses are the worms feeding—a combination of town and country through the leaf market.

Suppose this example be followed in America, and enable all to profit who will.

Let the farmers enrich their hedges and fields with the wealth-giving tree, send its leaves by wagon, boat, or railroad, and enable every citizen, who is tied by his business to the city, to utilize every idle hand in his family and empty room in his house, by providing the silk worms and the food for them, and mark out a way to industry, morality, and health, by raising silk.

Every one knows how important the raising of cotton and the manufacture of all its fabrics has been to America; why shall not silk become a staple, the equal of cotton, if the people and the legislators of each State wherein the industry is practicable shall take up the enterprise with an interest equal to the object in view? Individual and national benefit are therein combined with benevolence; it promises good will to all by furnishing employment to those too young or too feeble to endure exposure out doors, or heavy work; of such, thousands are within reach, even in our favored land.

The present prosperous state of the country, the prospective revision of the tariff (although it so alarms the silk manufacturers that they turn from us, and refuse any aid), make this the time to make every effort to secure the establishment of silk culture as a national industry. In 1755 Mrs. Pinckney, of South Carolina, took enough American silk to England for the making of three dresses. In 1761, Savannah had a filature and exported 8,829 pounds of raw silk. The last parcel brought for sale there was in 1790. There is no doubt that the cultivation of cotton superseded that of silk, in Georgia, at the period when the bounty on mulberry trees and cocoons was suspended. Surely there is room enough for both. History gives us the account of efforts in silk culture from time to time, started and abandoned from various hinderances, but *never* on account of soil or climate.

Two essentials to success, at the present time, are quantity and quality of cocoons. Quantity of cocoons will open filatures in many directions, and make the supply of raw silk equal to the demand of the manufacturers; and quality will secure the sale of all the raw silk produced at fair prices. To secure success, a reasonable but steady supply of money is needed, not only for the W. S. C. Association—we aim at no profit—but to enable us to start many who need it for the first season, at least. The expense is trifling, for the result; but all experience teaches that no matter how small the sum may be, we must have it to make a beginning with. The association has many appeals to advance small sums.

A cocoonery for one ounce of eggs, 40,000, will cost about $57—and one ounce is amply sufficient to begin with. Any room that can be well ventilated, and kept at a regular and moderate temperature, will make a cocoonery.

Twenty frames or hurdles, with twine, tacks, and time will cost about	$13 00
Racks for the frames	5 00
Ounce eggs (40,000)	5 00
One boy for four weeks	10 00
Man for two weeks	20 00
Total	$53 00

For the first week, any woman or child in the house can easily pick the leaves and feed the worms.

With patience and perseverance the mulberry leaf becomes silk.

I am glad to state that there is almost a certainty of a steam filature being established by the time the cocoons of 1882 are ready to be reeled. Hand reeling is too slow for business, and too costly in this country of good wages, to which the best workers come from all corners of the world. Cocoons weigh very light, so that the freight is small to send them to a filature, and the profit is on the raw silk, if of good quality.

CÆNURUS OF THE HARE.*

ANY ONE who has noticed the wild hare (*Lepus californicus*) which is brought in such quantities to our markets from November to March, must have occasionally observed upon their loins and thighs swellings of considerable magnitude. Many are killed in which these tumors have developed to the size of an orange, though probably none so greatly disfigured are ever found in the markets.

These swellings, which are well known to hunters and market men as "water blisters" or "water boils," are found in a very considerable proportion of the hares, but, so far as I have observed, do not occur in the smaller species which are popularly called rabbits. Although they are so frequently seen, I have never met with any one who had the slightest suspicion of their true nature—for these innocent-looking "blisters" are tape-worms in the larva stage, waiting patiently for their final transformation.

Tape-worms are exceedingly common, most animals harboring one or more, either in the perfect or the larva state,

* Read before the California Academy of Sciences, by Dr. Mary E. Curran.

but they are rare in reptiles. They are true parasites, living entirely at the expense of their host, and repaying him in too many instances with disease and death. Their life history is now tolerably well known; those which belong properly to the carnivora pass their larva stage in the flesh of some herbivorous animal which is the natural prey of its future host.

Tape-worms, in their perfect form are rather inconvenient than dangerous guests. They can be dislodged with comparative facility; but unhappily this is not true of the larvæ.

Those which may be said to belong to man, as a carnivorous animal, are *Tænia solium*, which comes to us from measly pork, and *Tænia medio-canellata*, which is derived from beef infested with vesicular larvæ, very similar in appearance to the "measle" Abyssinia is the chosen home of this tape-worm. The people of that country eat raw beef which is still warm and quivering. Small wonder then that the whole population is infested with this parasite; but as most evils have their attendant good, so have their efforts to obtain relief given to us one of our best remedies —kousso.

Tænia echinococcus, which, in the perfect form, inhabits the dog, is found in man only in the larva state, producing what was formerly called "hydatid disease," which is always dangerous and frequently fatal. It is quite rare in this country, but in Iceland, where the dogs live huddled together in huts with their masters, and cleanliness is a forgotten art, it prevails so extensively that one in seven of the population is said to be affected with it.

Among the lower animals a notable example of the ravages caused by tæniæ is found in the disease called "gid" in sheep, produced by a larva which selects the brain as a resting place. Van Beneden, in speaking of this parasite, says: "The introduction of gid into a country is a calamity. Every animal attacked is doomed, and the only remedy is to destroy by fire the head of every one which dies of the disease." This dreaded parasite is *Tænia cœnurus*, and in its perfect form is harbored by the dog and wolf.

The subject of this paper is also a *Cœnurus*, a name given to those *Tæniæ* which, in the larva state, develop many heads from a single vesicle by a process of budding. It has never been described from the hare, so far as I know, but Mr. C. B. Rose, of Norfolk, England, published, as long ago as 1834, an account of a cœnurus found in the rabbit of the warrens (*Lepus cuniculus*), which may be the same. Further investigations, and especially comparison of the perfect tape-worms, are necessary to settle this question

The more detailed description which follows has been carefully made, and as the material is abundant, can be readily verified by any one accustomed to the use of the microscope.

On removing the skin from a hare affected with cœnurus, one or more swellings, looking like bladders buried in the flesh, may be seen, ordinarily upon the loins or thighs, though they may be found in any part of the body. If the capsule of connective and muscular tissue which incloses the cœnurus be now carefully opened, a quantity of clear fluid and a bladdery vesicle escape. This vesicle is also filled with fluid, and has attached to its outer surface many smaller vesicles, and a great number, often many hundred papillæ, which, when fresh, are seen to be actively contracting. These papillæ, milk white in color and attached by slender pedicels to the vesicle, are about two lines in length and one in breadth at the widest part, which contains the head turned inward like the partly inverted finger of a glove. The body displays a number of transverse lines, indications of the future joints of the worm.

If one of these papillæ be carefully detached and placed under a microscope, moderate pressure upon the covering-glass will cause the inclosed head to protrude and bring to view its four sucking disks and double crown of pointed hooks, 14 or 15 in each row. The hooks of the inner row are double the size of the outer; but being attached half their length nearer the center, the points of all fall in the same circle. Just beneath the dermis are seen an immense number of round or oval bodies of a concentric structure, which effervesce strongly on the addition of sulphuric acid. These are the so-called calcareous corpuscles, and are supposed to act as a kind of external skeleton.

The head and neck of this cœnurus are much smaller in proportion to the body than are those of the cœnurus of the sheep, as it is shown in the drawings to which I have had access.

The natural hosts of the cœnurus of the hare are the dog and the wolf. Our wild dog, the coyote, will serve to illustrate the journey of its life. A hare badly infested with cœnurus becomes swollen and deformed, and as the loins and thighs are attacked by preference, his powers of locomotion are seriously impaired. In this condition he falls an easy prey to his hereditary foe.

The coyote swallows not only the hare, but its 10,000 contained larvæ, a circumstance which would undoubtedly give his victim a feeling of malicious joy, if he were in a condition to know anything at all about it. The larvæ are set free in the stomach of the coyote by the digestion of the vesicle, and a certain proportion succeed in attaching themselves, by their hooks and suckers, to the walls of the small intestine, fortunately only a very small proportion, for their way is beset with dangers, and their extraordinary fecundity is calculated in proportion to their chances of safety.

The tape-worm is a colony of hermaphrodites, each joint of which is a sexually complete animal, male and female, containing thousands of eggs. It reaches maturity in about six weeks, after which period the lower joints, and numerous free eggs are discharged at each evacuation, and deposited upon the ground, weeds, or grass.

The eggs are so small as to be quite invisible to the unaided eye, and being furnished with a very thick envelope, have considerable tenacity of life. The hare swallows these eggs, either by feeding upon the grass and weeds, or by drinking from pools of water into which they have been washed. In the stomach the thick envelope is digested, the contained embryo is set free, and immediately starts for its predestined resting place. This microscopic embryo is furnished with six hooklets, by means of which it penetrates the walls of the intestine and embeds itself in the muscular tissue. Here it ceases to move, its hooklets fall, and it slowly develops into the polycephalous vesicle first described.

This paper has not been written to discourage the use of the hare as an article of food; on the contrary, the aim has been to point out the remedy for an evil which is undoubtedly increasing. So far as is known this tænia does not develop in man, and if it were capable of doing so, the thorough cooking to which it is subjected would be a strong safeguard, underdone hare not being so popular a dish as roast beef rare, or ham warmed through.

From what has been said of the life history of the cœnurus, it is evident that if every affected hare were well boiled, or burned, the disease would become much less frequent. At present it is disseminated in such a manner as would almost lead one to suppose that the breeding of this parasite is an object greatly to be desired. These affected hares are sold every day in the market, and in the face of the general ignorance of the nature of the tumors, no blame can be attached to the venders. The health of the animal seems unaffected by the parasite he harbors, and in many cases they are so deeply buried as only to be discovered by incision.

These hares are either thrown away by the purchaser or are used for food after the tumors have been removed In either case they are eaten by dogs, which become infested in the same manner as the coyote, and like him convey infection to the hare again.

In the country this method of disposing of their bodies is still more objectionable, for they are found and eaten by various wild animals, and although the dog and wolf are the natural hosts of this cœnurus, it may have others, possibly the lynx and the fox.

In this way the vicious circle of disease is continually widening, and unless a change is made, we may expect, at no distant day, to find the hare, as an article of food, banished from our markets.

THE TINCAL TRADE OF ASIA.

THE last twelve months have been so unsatisfactory to the buyers of tincal (crude borax) that a few remarks may be of advantage to those interested, and the adoption of a few suggestions that may be made may to some extent remedy the present evil and losses to those who intend to embark in the trade the coming season. As many of the merchants in Calcutta have but little idea of the mode of the trade before its arrival in that port, the following information may be useful to all concerned.

The Bootus are the owners of the sheep that carry this product from the very heart of Thibet over the Himalayan Mountains into India. The tincal is collected by the poor native population from the side of the lakes in September, October, November, (many of these collectors only get from equal to a penny per day paid in cowries), and is brought into the villages in Thibet and sold at the bazaars. The owners of the sheep buy it from the small dealers, and put it into saddle bags, as much as thirty to forty pounds in each bag, or about equal in weight to the animal that is carrying it; some few goats are also employed in this trade. They then start on their wearisome long journey, many of the flocks with nothing but tincal. Every driver carries a distaff and bobbins, and, as they travel, they carefully collect every bit of wool that falls from the sheep or sticks to the thorny bushes, as the sheep come into contact with the bushes that drag their wool off. The wool is spun into yarn or strong thread, and then woven into cloth, which they make into bags. These are covered outside by sheepskins, to prevent the tincal from getting wet, and also to protect the woolen bags from getting torn by the thorny bushes.

Frequent deaths of the sheep and goats take place on the road. The flesh is always eaten by the drivers. From eight hundred to a thousand sheep make a drove. The sheep are driven from seven to nine miles per day, and it takes from six to eight weeks for the journey from starting point to Moradabad. They travel through a pass of the Himalayan Mountains, about a hundred miles north of Almira. In one part of the pass there is no grass for twenty-five miles. The underwood has to be cut down for the leaves to feed the sheep. Some parts of the pass are 15,000 feet above the sea level. The tincal is sold in the bazaars at Moradabad by the Bootus to native dealers, and it is sent from thence to Calcutta. The owners of the sheep take back, on their return journey, salt, rice, sugar, cowrie shells (which pass as coin), and small Birmingham and Sheffield wares.

When tincal was so cheap, about three years ago, in consequence of the large imports of borax from California, some of the owners of the flocks kept them in the plains, and carried ironstone packed in the tincal bags, from Ramghur to the government ironworks at Kumaon, at about one shilling per ton per mile. The tincal is called swab in some districts it passes through, but it is generally known under the name of tincal. The adulteration of the tincal commences at Moradabad and other points on the Indian side of the Himalayas; it is sent thence to Calcutta, some good and some mixed with sand and other impurities, and sold by the natives to the European markets, and sent principally to Liverpool or London. When a European merchant goes to a native dealer in Calcutta and makes a purchase of a few hundred bags great care is taken that all the visible bags contain prime tincal; the price per sack is fixed upon, and as soon as the buyer has left the go-down, many of the bags of good prime tincal are taken away and inferior bags of tincal are put in their place. The tincal is then shipped, good and bad all mixed together, and on its arrival the buyer discerns the inferior article and claims arbitration on account of inferior quality. The tincal is analyzed by chemists in London and Liverpool, most of whom differ in the results; two brokers are then fixed upon to make the allowance or award, and the result is generally a loss of from £3 to £8 per ton to the owner or shipper. With a view to prevent the sometimes unjust claims, the following mode is suggested, which would put a stop, first, to the fraud in India, and, secondly, to the fraud in England, which is that no European firm should ship tincal from Calcutta that contains any dust, but have the whole sifted through sieves of, say, twenty meshes. The tincal would come to this country perfectly pure, the potters would use it with perfect safety, and they would be able to get a better glaze, making it preferable to borax. The manufacturers of enameled iron goods prefer it, and, in fact, many of the German enameled iron makers will use nothing else for glazing when they can get it pure. Nearly all the consumers in England, Scotland, and other places would use it with perfect confidence and safety.

Before the discovery of boracic acid lagoons in Italy, the bulk of tincal was sold in London to borax refiners in Amsterdam, the works of which are all now closed. Samples have been received within the last six months from a newly discovered deposit in Nepaul, each crystal weighing from one to four ounces, and quite free from dust. If bulk parcels arrive from this new source equal to sample, adulterated tincal will find no sale in India or England, and native dealers will find it to their interest to sell the tincal pure. The new season tincal will be due in Calcutta in December, January, and February.—*Staffordshire Daily Sentinel.*

THE BELGIAN GEOGRAPHICAL PRIZE FOR 1885.—The King of Belgium has decreed a prize, to be offered in 1885, for the best system of popularizing the study of geography.

RAPID ANALYSIS OF OPIUM

By MM. PORTES and LANGLOIS.

TAKE from an average sample 7 grms. of the opium; wash out 3 grms. of slaked lime, and measure 70 c.c. of distilled water. Mix the opium and the lime very carefully, adding the water in small fractions, and leave the mixture for half an hour stirring from time to time. Throw the whole upon a filter and collect 53 c.c. of the liquid in a small glass provided with a lid. Add to the liquid 10 c.c. of ether, and agitate. Dissolve in the liquid 3 grms. ammonium chloride, agitating to promote solution, and let settle for two hours. Decant off the ether, put a fresh quantity in its place, agitate, and decant again. Collect the precipitate of morphia upon a filter without folds and 10 cm. in diameter, and wash the precipitate and the vessel with a few c.c. of cold distilled water. Wash the precipitate into the vessel which has served for precipitation by means of 50 c.c. of distilled water. Add 5 c.c. of dilute sulphuric acid, containing 1·617 per cent by measure of SO_4H_2 and 4 drops of neutral litmus. If the liquid becomes red the opium does not contain 10 per cent. of morphine, but if it is blue it exceeds the normal standard. To find the deficiency or the excess: if the opium is too weak, drop in with the burette a standard alkaline solution till the liquid is neutralized; if too strong, an acid liquid is dropped in, in a similar manner.

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